Science Library

MAR 2 0 1946

Vol. 73 MARCH-APRIL, 1946 No. 2

Bulletin

of the

Torrey Botanical Club

and

Torreya

Editor

Harold W. Rickett

Associate Editors

Irving W. Bailey — Adriance S. Foster
Stanley A. Cain — Henry Allan Gleason
M. A. Chrysler — John W. Shive

for Torreya

Harold H. Clum — Frances E. Wynne

CONTENTS

Carlton Clarence Curtis, 1864–1945 ..... *Edwin B. Matzke* 103
Further Studies on the Erysiphaceae of China ..... *F. L. Tai* 109
Noteworthy Plants of Texas—V. Additional Psoraleas. *B. C. Tharp and Fred A. Barkley* 123
Types of Anthesis in Hemerocallis and Their Heredity in F_1 Hybrids. *A. B. Stout* 134
The Mosses of Georgia—II. The Coastal Plain. *Ruth O. Schornhorst* 152
The Effect of Colchicine and Acenaphthene in Combination with X-rays on Plant Tissue—III ..... *Michael Levan* 167
Remarks upon Certain Hawaiian Labiatae and Compositae. *Earl Edward Sherff* 184
The Gilia aggregata Group ..... *Edgar E. Wherry* 193
Torreya 202
Short Articles and Notes. Notes on the Grasses, Sedges and Rushes of the Great Swamp (New Jersey): *William F. Rapp and Janet L. C. Rapp.* Additional Introduced Plants in the Aleutian Islands: *Egbert H. Walker.* Plantas Medicinales, Aromaticas o Venenosas de Cuba (*Reviews*). Proceedings of the Club.
Index to American Botanical Literature 208

Published for the Club bi-monthly

by

THE SCIENCE PRESS PRINTING COMPANY
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PENNSYLVANIA

THE TORREY BOTANICAL CLUB

Officers for 1946

President: P. W. Zimmerman

Vice-presidents: John A. Small, Henry K. Svenson

Recording Secretary: Frances E. Wynne

Corresponding Secretary: Jennie L. S. Simpson

Treasurer: Edmund H. Fulling

Editor: Harold W. Rickett

Business Manager: Ann M. Hanson

Bibliographer: Mrs. Lazella Schwarten

The Bulletin of the Torrey Botanical Club

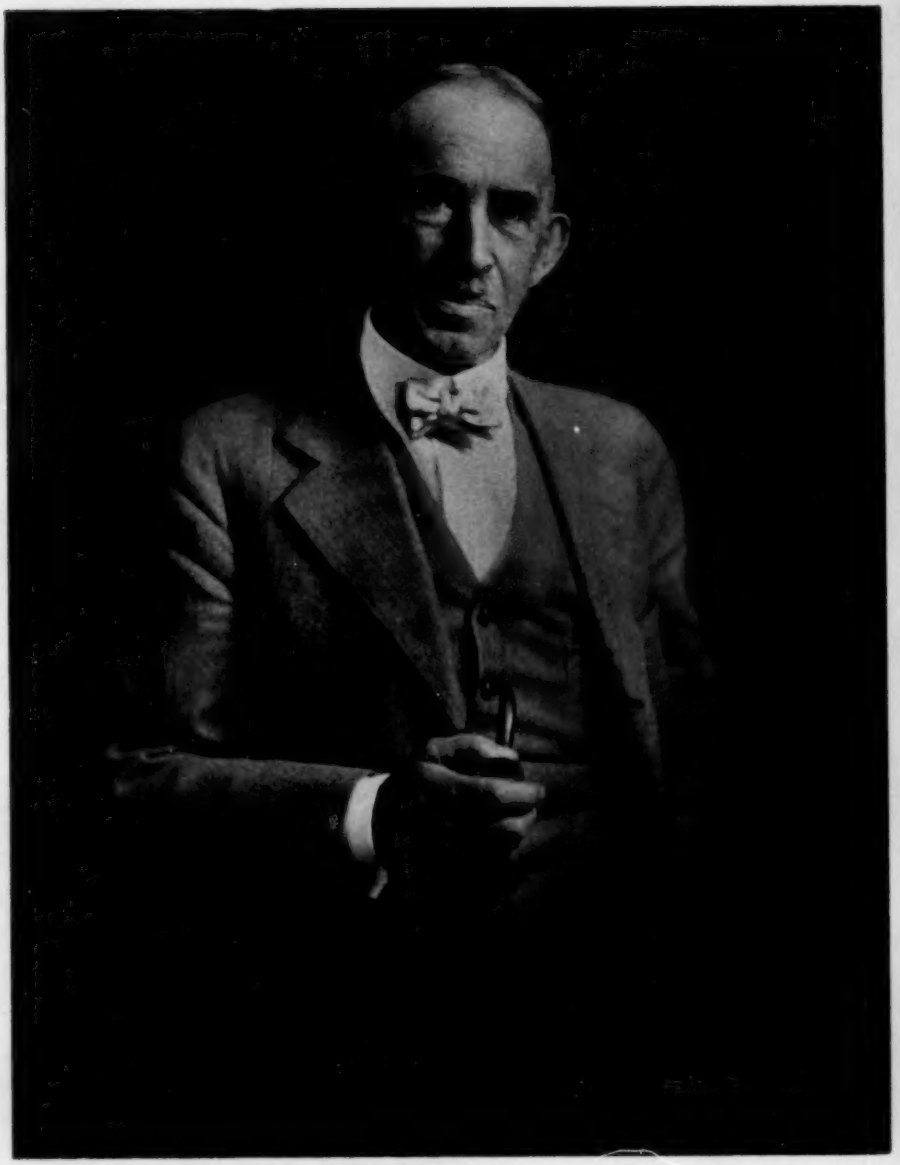
and Torreya

Subscriptions, dues and inquiries about back numbers should be sent to the office of publication, N. Queen St. and McGovern Ave., Lancaster, Pa., or to Dr. Edmund H. Fulling, The New York Botanical Garden, New York 58, N. Y. Correspondence about advertisements and circulation should be addressed to Dr. Ann M. Hanson, Box 12, Schermerhorn Hall, Columbia University, New York 27, N. Y. Communications about exchanges should be sent to Dr. Jennie L. S. Simpson, Hunter College, New York 21, N. Y. Manuscripts intended for the Bulletin should be sent to Dr. H. W. Rickett, The New York Botanical Garden, New York 58, N. Y. Short notes for Torreya may be addressed to Dr. H. H. Clum, Hunter College, New York 21, N. Y.

Claims for missing numbers must be made within 60 days from the date of issue.

The subscription price of the Bulletin of the Torrey Botanical Club (including Torreya) is $7.00 a year except to active members of the Club. Of the annual membership dues, $3.50 covers a year's subscription to the Bulletin.

Entered as second-class matter October 8, 1940 at the post office at Lancaster, Pa., under the Act of March 3, 1879. Accepted for mailing at the special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, section 538, P. L. & R.



CARLTON CLARENCE CURTIS

Photograph by Hartrach

UNIV. OF MICH.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 103–107 MARCH, 1946

CARLTON CLARENCE CURTIS
1864–1945

EDWIN B. MATZKE

Professor Carlton C. Curtis wove his life inextricably into the science of botany, to which he was completely devoted, and into Columbia University, which he served long and faithfully. Through his efforts, both the science and the University have been deeply enriched.

Carlton Clarence Curtis was born near Syracuse, N. Y., in 1864. His early training was at Syracuse University, from which he received his bachelor's degree in 1889, and at Columbia University, which awarded him the master's degree in 1892. He then returned to Syracuse for the doctorate in 1893. Subsequently he studied at the University of Cambridge in England, where he was associated with Francis Darwin, and at the University of Leipzig in Germany, where he worked under the brilliant plant physiologist Pfeffer. The training which he received under these two men is reflected in his publications in the field of plant physiology.

For two years Dr. Curtis was principal of Fayetteville Union School, N. Y., and for two additional years he was an instructor in natural science in Brooklyn Polytechnic Institute, N. Y. In 1892 he was appointed assistant in Columbia University, and from that year until his retirement in 1934 he was associated with its Department of Botany; it was there that he did his life work.

The published material of Dr. Curtis covers a wide range of topics and attests the catholicity of his interests. His earliest investigations dealt with the structural and cellular features of orchid seeds and their significance in classification. He then made careful studies of the early stages in the development of the lichen thallus, and followed these with an account of algae characteristic of New York harbor. In 1898 he published a lucid discussion of the evolution of assimilating tissue and the fundamental nature of the leaf in the plant kingdom. During the early years of the twentieth century, Professor Curtis turned his attention largely to the young and growing science of plant physiology. In a series of experiments he analyzed turgidity in the hyphae of fungi under controlled and varying environmental conditions. Next there followed a series of studies on transpiration. The work performed by the plant in transpiration was computed, and subsequently the daily transpiration curve in light and in darkness and correlated stomatal activity were recorded and interpreted. He then studied the characteristics of etiolation developed by plants growing in feeble light. Professor Curtis also pub-

[THE BULLETIN for January–February (73: 1–102) was issued January 7, 1946.]

lished an article on successive flowering of the tulip tree in one season, and another on the conifers of the northwest. From a consideration of his investigations, it is evident that his research interests were unusually broad. During these years he also prepared numerous book reviews.

Professor Curtis published three books. The first, *A textbook of general botany*, appeared in 1897; this was modestly intended as "an exposition" of the laboratory work required of beginners at Columbia, but it is a sizable, complete and well-illustrated volume. The second book, *Nature and development of plants*, was first put out in 1907, and has gone through numerous editions and printings. It has been used widely as a text-book in elementary courses in botany in colleges and universities throughout the United States. It is written in pleasant literary style, and in this respect is entirely different from the stilted approach so characteristic of scientific text-books. *Nature and development of plants* was a superior presentation of the whole field of botany; the second part of this work, dealing with the plant kingdom, is still unsurpassed as a brief discussion of the groups of plants. Dr. Curtis' third book, *A guide to the trees*, appeared in 1925. Although complete treatises on the trees of northeastern North America were available, this was intended as a brief but scientifically accurate guide, written in language which could easily be understood. The drawings were made by Mrs. Curtis. This volume has also had wide use and has passed through numerous printings. It is of course distinctly unusual for a man trained in physiology to write a successful book on trees. But Professor Curtis was thoroughly familiar with plants in the field; he personally assembled the sizable herbarium which is now used as the teaching herbarium of Columbia University. In a way achieved by few men, Dr. Curtis was a general botanist, specifically trained in various fields, and capable of seeing the plant as a whole and of visualizing the problems connected with it in three dimensions.

This breadth of outlook and training was to a considerable extent responsible for his remarkable success as a teacher; for in spite of his accomplishments as a scientist and as an author, his greatest achievement was probably in the classroom. Dr. Curtis taught the large general course in elementary botany throughout his long period of association with Columbia University. For many years he conducted the graduate work in plant morphology; he also gave a course in Columbia College on algae, and another in the School of Engineering on trees and timbers. Dr. Curtis' lectures were always carefully prepared, delivered in fine English, and touched with humor. The thousands of students who passed under his tutelage respected him for his learning, admired him for his ability as a teacher, and sought his counsel because of his sympathetic and human understanding.

Dr. Curtis joined the Torrey Botanical Club in 1892. For more than twenty years he was one of its very active members, frequently reporting

on the program and serving in sundry capacities. He was treasurer in 1906 and 1907, and associate editor from 1898 to 1902; he served on the program committee for two years, on the committee on admissions for four years, and on the local flora committee from 1909 to 1920. He was elected to life membership in 1934. He was also a member of Phi Beta Kappa, Sigma Xi, and numerous scientific societies.

In his earlier years Dr. Curtis was a man of buoyant disposition and keen good humor, animated, energetic, and with a wide circle of friends. He was always interested in camping and fishing; even in later years he could cast a fly with fine precision, and his skill with a rifle never left him. He liked to spend his spare hours in the field. Sometimes on foot and sometimes by canoe, he would disappear into the vanishing wilderness in various parts of the United States and Canada to seek refreshment. When he was no longer vigorous enough to do this, he built simple cabins—always beyond the end of the trail, and there he studied plants and birds under undisturbed conditions. Dr. Curtis was an accomplished naturalist; he kept records and made observations in the field for many years, and he had a keen appreciation of plant and animal life, in which he never lost interest.

Unlike most scientists, Professor Curtis was widely read in literature, in the Bible, and in world affairs. Poetic and sensitive by nature, he had a natural appreciation of good literature. He traveled extensively, not only in North America, but in little-frequented parts of Europe, and in the Holy Land. Even in his advancing years he was still the witty, animated, brilliant conversationalist, with an almost endless fund of true stories, drawn mostly from his own experiences. His broad scientific training, his interest in wild life, his appreciation of literature, his wide travels, his sense of humor, and his forceful personality all blended to make him a man of unusual richness and charm. Although thoroughly kindly, he was strong in his conviction of right and wrong, completely impatient with sham and pretext, and unwilling to mince his words. Such men frequently suffer internally in an imperfect world.

Professor Curtis spent more than ten years in idyllic retirement. He continued to travel to some extent, but lived mostly at Tryon, North Carolina, where the Blue Ridge Mountains roll away from the Piedmont. Here he and his wife, Ellison Gwyn Curtis, built an unpretentious but attractive home, facing the mountains. They were singularly blessed in having in common similar philosophies of life, love of good literature, interest in plants and birds, appreciation of the beautiful, fondness for camping, fishing, and travel, and a sense of humor.

Professor Curtis died at his home at Tryon on April 10, 1945. In his passing the science of botany lost one of its greatest teachers and one of its finest scholars. His long and fruitful life was one of rich accomplishment and

noble simplicity. The letters which so many of his students have written are at once a mark of the esteem in which they held him and a tribute to the inspiration which he afforded them. They all speak of him in similar terms, as one who was a thorough gentleman, whose life reflected the quiet greatness of his soul.

THE PUBLISHED WORK OF CARLTON CLARENCE CURTIS

An examination of the seeds of some native orchids. Bull. Torrey Club **20**: 183–192. *pl. 150–152.* 10 My 1893.

A contribution to the history of the formation of the lichen thallus. Jour. N. Y. Micros. Soc. **10**: 63–69. *pl. 44.* Jy 1894.

Some interesting features of well-known plants of New York Harbor. Jour. N. Y. Micros. Soc. **11**: 63–73. *pl. 50–51.* Jy 1895.

(Review of) Pflanzenleben. Volume I. KERNER VON MARILAUN, ANTON. Transl. by Prof. F. W. OLIVER as The natural history of plants. Bull. Torrey Club **22**: 403–404. 30 S 1895.

A text-book of general botany. iii–viii +359 p. *f. 1–87.* Longmans, Green and Co. New York, London, and Bombay. 1897.

The evolution of assimilating tissue in sporophytes. Bull. Torrey Club **25**: 25–29. 25 Ja 1898.

Turgidity in mycelia. Bull. Torrey Club **27**: 1–13. 24 Ja 1900.

The work performed in transpiration and the resistance of stems. Bull. Torrey Club **28**: 335–348. 19 Je 1901.

Second flowering of the tulip-tree. Jour. N. Y. Bot. Gard. **2**: 136–138. S 1901.

MacDougal's Elementary plant physiology. (Review of: MACDOUGAL, D. T. Elementary plant physiology.) Torreya **2**: 56–57. 12 Ap 1902.

Some observations on transpiration. Bull. Torrey Club **29**: 360–373. 20 Je 1902.

A course in botany and pharmacognosy. (Review of: KRAEMER, HENRY. A course in botany and pharmacognosy.) Torreya **3**: 25–27. 19 F 1903.

The influence of light and darkness upon growth and development. (Review of: MACDOUGAL, D. T. The influence of light and darkness upon growth and development.) Torreya **3**: 41–43. 20 Mr 1903.

Observations on etiolation. Torreya **3**: 70–73. 12 My 1903.

The desert botanical laboratory of the Carnegie Institution. (Review of: Carnegie Institution of Washington, Publication No. 6.) Torreya **4**: 40–41. 12 Mr 1904.

The pines of the Northwest. Shields' Mag. **1**: 383–385. *illust.* N 1905.

Winton's Microscopy of vegetable foods. (Review of: WINTON, A. L. The microscopy of vegetable foods, with special reference to the detection of adulteration and the diagnosis of mixtures.) Torreya **6**: 94–96. 23 My 1906.

Nature and development of plants. vii + 471 p. *f. 1–342.* Henry Holt & Co. N. Y. 1907.

Kraemer's Text-book of botany and pharmacognosy. (Review of: KRAEMER, HENRY. A text-book of botany and pharmacognosy.) Torreya **7**: 145–147. 19 Jy 1907.

De Vries' Plant breeding. (Review of : DE VRIES, HUGO. Plant breeding.) Torreya **7**: 186–190. 21 S 1907.

A biographical sketch of Lucien Marcus Underwood. Bull. Torrey Club **35**: 1–12. *Port.* "Ja" (29 F) 1908.

Hanausek's Microscopy of technical products. (Review of: HANAUSEK, T. F. The microscopy of technical products. Revised and transl. by ANDREW L. WINTON, with the collaboration of KATE G. BARBER.) Torreya **8**: 79–80. 29 Ap 1908.

Britton's North American trees. (Review of: BRITTON, NATHANIEL LORD, with the assistance of JOHN ADOLPH SHAFER. North American trees.) Torreya 8: 167–170. 29 Jy 1908.

Knuth's Handbook of flower pollination. (Review of: KNUTH, PAUL. Transl. by J. R. AINSWORTH. Handbook of flower pollination. Volume II.) Torreya 8: 220–223. 26 S 1908.

A guide to the trees. 1–208 p. *illust.* Greenberg, Publisher Inc. New York. 1925.

COLUMBIA UNIVERSITY
NEW YORK

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2. PP. 108–130 MARCH, 1946

FURTHER STUDIES ON THE ERYSIPHACEAE OF CHINA[1]

F. L. TAI[2]

Taxonomic work in fungi is usually done with herbarium material. Most of the taxonomists still cling to the old conception of the rigidity of species. Allowance is not, as a rule, duly made for the effect of environment and host on the variation of morphological characters. Salmon is conservative in species limitation, recognizing in his monograph of the Erysiphaceae (Mem. Torrey Club **9**: 1–292. 1900) only 49 species and 11 varieties for the whole world. The fact that Salmon's monograph has remained the standard work for so many years is not without reasons. After many years' study on the Erysiphaceae of China both in the field and in the laboratory the writer has come to believe that a broad view on species limits should be taken.

This paper gives mainly results of careful comparative studies of all available collections of most of the species of Erysiphaceae so far reported from China. It seems advisable and proper to keep the collective species: *Erysiphe Polygoni*, *Erysiphe Cichoracearum* and *Microsphaera Alni* as emended by Salmon. One variety of *Erysiphe*, two species of *Microsphaera* and one species and one variety of *Uncinula* are described as new.

SPHAEROTHECA FULIGINEA (Schlecht.) Pollaci.

On *Bidens bipinnata*, FUKIEN: Shaowu, *Loh 16,221*. On *Cosmos bipinnata*, YUNNAN: Kunming, *6362*.[3] On *Cucurbita Pepo*, YUNNAN: Kunming, *7582*. On *C.* sp., YUNNAN: Kunming, *4051;* Chengkiang, *4048*. On *Hibiscus mutabilis*, YUNNAN: Kunming, *7218, 8022*. On *H. syriacus*, YUNNAN: Kunming, *8016*. On *Impatiens Balsamina*, YUNNAN: Kunming, *4110;* Tali, *4109;* FUKIEN: Shaowu, *Loh 16,523*. On *Taraxacum orientale*, HOPEI: Kalgan, *Wu 113*.

Perithecial stage rarely occurs on members of the Cucurbitaceae. *Erysiphe Cichoracearum* has been recorded on them in Europe, North America, and Japan; *E. Humuli* in Europe (Marie, R., Bull. Soc. Mycol. Fr. **46**: 231. 1930) and *Sphaerotheca fuliginea* in Central Europe, Russia, and Japan. In China only *Sphaerotheca fuliginea* has been so far found on *Cucurbita Pepo* (Sinensia **3**: 98. 1932). In a previous publication (Tsing Hua Univ.

[1] Paper No. 27 from the Division of Plant Pathology, Institute of Agricultural Research, Nat. Tsing Hua University, Kunming, Yunnan, China.

[2] The writer wishes to acknowledge his indebtedness to the following gentlemen for sending specimens for this study: Professors L. T. Lin, Tsing-tsuh Loh; Drs. C. S. Wang, H. K. Chen, L. Ling and C. T. Wei; Messrs. Y. S. Wu and W. L. Hsian, and especially to Mr. C. Y. Wu for identifying host plants.

[3] This refers to the Tsing Hua Pathological Herbarium number for additional collections mostly made in Yunnan since 1939.

Inst. Agr. Res. Bull. **6**: 22. 1941) the writer has referred the powdery mildews on *Cucurbita* sp. and *Momordica charantia* collected in the province of Yunnan to *Erysiphe Cichoracearum*, relying at that time on the erroneous determination of the conidial stage. Since then perithecia have been found, on re-examination, on two of the collections, nos. 4048 and 4051. The fungus again proves to be *Sphaerotheca fuliginea:* perithecia 89–106 μ in diameter; cells of the perithecial wall 17–29 μ wide, mostly above 21 μ; asci subglobose or broadly ovate, 69–91 × 57–69 μ; spores 16–20 × 11–16 μ. Conidia in chains, 29–34 × 20–21 μ with fibrosin bodies.

SPHAEROTHECA LANESTRIS Harkness.

On *Lithocarpus dealbata*, YUNNAN: Kunming, *4111*. On *Quercus Delavayi*, YUNNAN: Kunming, *7237*.

The occurrence of this species in China was reported by the writer in 1935 (Bull. Ch. Bot. Soc. **1**: 13. 1935). In the collections of powdery mildew made at different places in the province of Yunnan, a form of *Sphaerotheca lanestris* with evanescent mycelium has been found on *Lithocarpus dealbata* and *Quercus Delavayi:* hypophyllous; mycelium evanescent; perithecia subgregarious in spots, 90–114 μ in diameter; appendages usually obsolete or few, short, branched, thick-walled, hyaline, at the base of the perithecium; asci at first fusiform, becoming broadly ovate or subglobose after absorbing enough water, 86–105 × 63–75 μ; spores ellipsoid or oblong, 24–31 × 16–20 μ. The fusiform asci, when not fully expanded, measure 114–157 × 54–63 μ. A novice would consider the present plant as a distinct species if he took the fusiform, not fully expanded asci as typical. (Fig. 1.)

The writer re-examined specimens of the collection, *Cheo 2851*, collected by Mr. S. Y. Cheo in Kwangsi, which had been referred to *Sphaerotheca lanestris* in 1935 (l.c.) as above mentioned, and found that the fully expanded asci measure 77–100 × 60–66 μ and are also broadly ovate or subglobose in shape. The Yunnan form on *Lithocarpus dealbata* and *Quercus Delavayi* is no doubt identical with the former in spite of the fact that its mycelium is evanescent. The character of the mycelium is, therefore, not a constant one in *Sphaerotheca lanestris*.

SPHAEROTHECA PANNOSA (Wallr.) Lev.

On *Rosa centifolia*, YUNNAN: Kunming, *4112*. On *R. multiflora*, YUNNAN: Kunming, *4113*. On *R. rugosa*, KIANGSU: Wusih, U. N. Path. no. 3915.

The plant on *Rosa rugosa* (U. N. Path. no. 3915) was formerly referred to *Sphaerotheca Humuli* (Bull. Ch. Bot. Soc. **1**: 13. 1935). Re-examination of both the perithecial and conidial stages of the original collection shows that the plant should be identified as *Sphaerotheca pannosa*. Its description follows:

Amphigenous; mycelium persistent, thick, effused or forming patches, white at first, becoming gray or brownish, also on petioles; conidia[4] in chains (2–4), cylindrical, with fibrosin bodies, 24–30 × 10–15 μ, conidiophores 4–5-celled, 107–149 × 8.5–10 μ, perpendicular to the hyphae. Perithecia gregarious to scattered, immersed in the persistent mycelium which is thick-walled, hyaline, about 5–6 μ thick, 81–97 μ in diameter; cells of the perithecial wall obscure, 10–16 μ wide (mostly 11–13 μ); appendages few, 1–10, often obsolete, tortuous, thick-walled up to the apex, brownish or only colored at the basal part, hyaline or subhyaline at the upper part, very short (1/5) to twice as long as the diameter of the perithecium, usually short, 3.6–5.0 μ wide, 1-septate at the base; asci globose or subglobose, rarely shortly stalked, 89–104 × 76–83 μ; spores 8, ellipsoid, 27–34 × 16–20 μ.

Two species of *Sphaerotheca* have been recorded on *Rosa* spp.: *Sph. pannosa* and *Sph. Humuli*. *Sph. pannosa* is close to *Sph. Humuli*, but differs mainly in the persistent, thick, and pannose mycelium, the shorter and tortuous appendages, and the larger asci. The conidia of the former species are also much shorter and narrower than those of the latter. On account of these distinct characters the present form is referred to *Sph. pannosa*. In the description of this fungus by Salmon (Mem. Torrey Bot. Club **9**: 66. 1900) the appendages are described as "very short." Those of the present plant are usually short, few, and sometimes obsolete, but often short and long ones occur on the same perithecium, the long ones attaining a length up to twice as great as the diameter of the perithecium.

According to Woronichine (Bull. Trim. Soc. Myc. Fr. **30**: 398. 1914) the appendages of *Sph. pannosa* on peach are 10–15 in number, clear brown and short ("15–30" μ long), but sometimes attaining a length of 70 to 90 u long (perithecia "70–93.6" μ in diam.). Schwarze in his "Parasitic fungi of New Jersey" (New Jersey Exp. Sta. Bull. **313**: 33. *f. 120.* 1917) stated that the appendages of *Sph. pannosa* are few, very short, and tortuous, but his illustration of the perithecium shows eight colored tortuous appendages which are at least as long as the diameter of the perithecium. From these it is evident that the appendages of *Sph. pannosa* are not uniformly "very short" as stated by Salmon.

SPHAEROTHECA WRIGHTII (B. & C.) v. Hoehnel.

On *Quercus glauca*, FUKIEN: Shaowu, *Loh 16,400*.

Hypophyllous; mycelium persistent, forming definite patches; brown hairs from the mycelium, sickle-shaped or various in shape, occasionally branched, thick-walled to the apex; perithecia 60–74 μ in diameter; cells of the perithecial wall obscure, those of the inner wall 6–15 μ wide; appendages

[4] According to Mlle. Bouwens (Phytopath. Lab. Willie Commelin Scholten Meded. 8: 3–47. 1924) the average length of the conidia of *Sph. pannosa* varies between 22.92 and 28.68 μ, the average width between 13.63 and 15.81 μ. Conidia of *Sph. Humuli* including *Sph. fuliginea* were found by her to vary in length between 26.65 and 39.89 μ and in width between 16.22 and 22.26 μ.

few, 1–4, at the base of the perithecium, tortuous, brown, short (equaling the diameter of the perithecium) and thick-walled; asci broadly ovate, 57–71 × 44–54 μ; spores ellipsoid or ovoid, 17–23 × 11–16 μ.

Sphaerotheca Wrightii is distinct from *Sph. lanestris* by the presence of the brown, sickle-shaped hairs, smaller perithecia, asci, and spores.

PODOSPHAERA LEUCOTRICHA (E. & E.) Salmon.

On *Malus spectabilis*, YUNNAN: Kunming, *5258*.

This fungus is common at Tapugi, Kunming, and causes serious disease in *Malus spectabilis*. The perfect stage has not yet been collected. Its conidial stage is as follows: mycelium amphigenous and caulicolous, persistent, thick, effused; conidiophore 4–5-celled, 74–114 × 8.6–11 μ; conidia in chains, ovoid, broadly elliptic or oblong, containing fibrosin bodies, 21–23 × 14–19 μ.

PODOSPHAERA OXYACANTHAE (DC.) de Bary.

On *Crataegus scabrifolia*, YUNNAN: Kunming, *7927*.

Only the conidial stage was collected. It shows the following characters: mycelium amphigenous, persistent, forming definite patches; conidiophores 5–6-celled, 129–200 × 7–9 μ; conidia in chains, ovoid or oblong, 20–27 × 10–13 μ.

PODOSPHAERA TRIDACTYLA (Wallr.) de Bary.

On *Prunus Persica*, YUNNAN: Kunming, *7910*.

Amphigenous, mainly hypophyllous; mycelium evanescent; perithecia scattered to gregarious, cells of the perithecial wall obscure, 8.6–11 μ wide, 83–90 μ in diameter; appendages 2–4, septate, 3–5 times dichotomously branched at apex; ultimate branchlets recurved; asci 59–70 × 57–64 μ; spores 19–27 × 13–17 μ.

ERYSIPHE CICHORACEARUM DC. *E. Plantaginis* (Link) Sawada, Agr. Gov. Res. Inst. Formosa Report No. **24**: 49. 1927. *E. tabaci* Sawada, Ibid.: 43. 1927. *E. lamprocarpa* (Wallr.) Duby in Blumer-Beiträge Kryptogamenflora der Schweiz **7** (1): 275. 1933.

On *Nicotiana tabacum*, YUNNAN: Kunming, *4053, 4137, 5255;* Shihping, *6940;* Tachwang, *4054*. On *Plantago major*, YUNNAN: Kunming, *4103*.

Sawada (l.c.) and Blumer (l.c.) restored the form of the collective species, *Erysiphe Cichoracearum*, on the genus *Plantago* to specific rank, and named it *E. Plantaginis* and *E. lamprocarpa* respectively as a result of cross-inoculation experiments and on minor morphological differences. In a study of the conidial stage of species of *Erysiphe* in Formosa, Sawada found that the conidiophores of that genus could be divided into three types: (1) conidiophore perpendicular to the hypha without enlargement at the base: forms on tobacco, poppy, *Leonurus sibirica* and *Leucas javanica* have this type of conidiophore; (2) conidiophore arising from the side of the hypha with its basal part curved: forms on *Plantago, Lactuca debilis, Sonchus*

arvensis, etc.; (3) conidiophore perpendicular to the hypha with the basal cell enlarged: *E. graminis*. *E. Plantaginis* was separated by Sawada from the other forms of *E. Cichoracearum* mainly by its inability to infect hosts other than *Plantago major*, and the curved basal part of the conidiophore. Regarding the latter the present writer has found perpendicular conidiophores in the form of *Erysiphe Polygoni* on *Pisum sativum*, but curved conidiophores in that of the same species on *Vicia Faba* in the material collected at Kunming. From this it is clear that this minor morphological difference of the conidiophore is not of sufficient importance for differentiating species.

Blumer (l.c.) stated that *E. lamprocarpa* differs from other forms of *E. Cichoracearum* sensu lato by its very numerous and short appendages as well as its long and narrower conidia ("35–39" μ long, "16–19" μ wide). On re-examination of the Chinese form of *E. Cichoracearum* on *Plantago major* and also of fresh material of the conidial stage, it has been found that the number of appendages varies from 20 to 60 or more. Short and long ones occur on the same perithecium measuring from (37)100 to 294 μ in length. They are never uniformly short and numerous. Sawada described the appendages of the Formosan form as several in number, long and short on the same perithecium, measuring 36–200 × 8 μ. The size of the conidium of the Chinese form, according to the measurements of the writer–26–40 × 14–18 (21) μ–, is very close to that of Blumer and Sawada. But the conidium of a form of *E. Cichoracearum* on tobacco collected at Kunming is practically of the same size as that of the fungus on *Plantago:* 26–41 μ long, 14–18 μ wide.

The conidiophore of the form on tobacco and poppy is said to be perpendicular to the hypha. On that account this form was raised to specific rank by Sawada as *E. tabaci*. It is similarly untenable for the reason already stated.

It is of interest to note that *E. Cichoracearum* has been recorded on *Helianthus annuus* in Europe, North America, and Japan, while in their studies of Erysiphaceae of China Wei and the present writer have so far only found *E. fuliginea* on that host plant. Teng also reported the same species on the latter (Contr. Biol. Lab. Sc. Soc. China **8**: 7. 1932). Although *E. Cichoracearum* has been reported on *Helianthus annuus* from this country by Chu (Jour. Agr. Assoc. China **54**. 1927) this report might have been based on the conidial stage alone, for the conidium of *E. Cichoracearum* is often separated with difficulty from that of *E. fuliginea*. In the Tsing Hua Pathological Herbarium there is one collection of *Erysiphe*, no. 4052, on *Helianthus annuus* collected at Chengkung and identified as *E. Cichoracearum* by Prof. L. T. Lin. The writer did not succeed in finding any perithecia on specimens of that collection and suspects that this fungus also might be *E. fuliginea*.

ERYSIPHE GRAMINIS DC.

On *Triticum aestivum*, YUNNAN: Kunming, *7957;* Chengkung, *4057, 4056;* Tachwang, *5330;* Mengtze, *5331, 5354;* Jautung, *4060;* Tungchuan, *4061;* Hsungtien, *4062;* KWANGTUNG: Canton, *4059;* SHENSI: Yen-an, *Wu 1000.* On *Hordeum vulgare*, YUNNAN: Kunming, *5367;* Chengkiang, *5318;* Lunan, *5336;* I-Liang, *5342;* Mengtze, *5329.*

ERYSIPHE POLYGONI DC. *E. Glycines* Tai, Lingnan Sci. Jour. **18**: 457. 1939.

On *Amphicarpaea Edgeworthii*, YUNNAN: Kunming, *7904, 7606.* On *Begonia yunnanensis*, YUNNAN: Kunming, *7924, 7919.* On *B. Evansiana*?, HONAN: Sunghsien, *Wang 1915.* On *Castanopsis concolor*, YUNNAN: Kunming, *8027.* On *C. Delavayi*, YUNNAN: Kunming, *4194, 7204, 7942;* Chengkiang, *5671;* Yuankiang, *6690, 6666;* Merhkiang, *6986.* On *C.* sp., SIKANG: Sichan, *8497.* On *Lathyrus palustris*, YUNNAN: Kunming, *8151, 8150.* On *Pisum sativum*, YUNNAN: Chengkung, *4064;* FUKIEN: Shaowu, *Loh 18,259.* On *Polygonum nodosum*, FUKIEN: Yungan, *7518.* On *Plectranthus eriocalyx*, YUNNAN: Kunming, *8206.* On *Quercus Schottkyana*, YUNNAN: Kunming, *4066, 8018, 8021.* On *Sambucus adnata*, YUNNAN: Kunming, *5282, 5283, 5298.* On *Thalictrum reticulatum*, YUNNAN: Chichushan, Pinchuan, *4047.* On *T. Delavayi*, YUNNAN: Kunming, *7941.* On *T.* sp., HONAN: Sunghsien, *Wang 2400.* On *Vicia dasycarpa*, YUNNAN: Kunming, *7818.* On *V. Ervilla*, YUNNAN: Kunming, *7820.* On *V. Faba*, YUNNAN: Kaiyuan, *4063;* Chengkung, *5317;* Kunming, *7556.* On *V. moatha*, YUNNAN: Kunming, *7819.* On *V. sativa*, YUNNAN: Kunming, *7491.* On *V. tetrasperma*, YUNNAN: Kunming, *7290.* On *V. villosa*, YUNNAN: Kunming, *7821.*

The appendages of all these collections vary much in length on the same perithecium, and in number on the same specimen. The size of the perithecium and the number of ascospores also vary greatly. All these collections are, therefore, referred to *Erysiphe Polygoni* as emended by Salmon. A careful comparative study has also been made of the other available collections; the characters of these collections grade into one another in such a way that it does not seem feasible to split the collective species, *E. Polygoni*, into many as Blumer has done.

The fungus on *Castanopsis* has relatively smaller perithecia and uniformly very short and numerous basal appendages. But when all its characters are considered as a whole, it is still within the limits of *E. Polygoni* sensu lato. The characters of this fungus follow: epiphyllous; mycelium persistent, effused or forming definite patches; perithecia gregarious to scattered, cells of the perithecial wall 7–13 μ wide, 60–94 μ in diameter; appendages basal, numerous, flexuose-contorted, hyaline or brownish, 1- or mostly non-septate, not branched or 1–2 dichotomously branched at apex, $\frac{1}{2}$ to $\frac{2}{3}$ of the diameter of the perithecium; asci 2–4, broadly ovate or subglobose, with or without a very short stalk, 46–60 × 40–54 μ; spores 5–7, rarely 4 or 8, oblong, 21–29 × 11–14 μ.

A species of *Erysiphe* on *Epimedium* from Honan, although showing affinity with *E. Polygoni*, is remarkable in having larger asci and longer spores. It is here considered as a new variety of *E. Polygoni:*

ERYSIPHE POLYGONI var. **Epimedii** Tai, var. nov.

On *Epimedium* sp., HONAN: Sunghsien, 1942, C. S. Wang, *Wang 2520*, TYPE.

A typo differt ascis 64–80 × 36–51 μ majoribus, sporidiis 20–34 × 10–14 μ longioribus.

This variety has larger asci and longer spores. It shows the following

characters: hypophyllous; mycelium persistent, effused and arachnoid; perithecia subgregarious to scattered, cells of the perithecial wall 10–14 μ wide, 104–129 μ in diameter (mostly 120 μ); appendages 15–22, 1–5 times the diameter of the perithecium, long and short on the same perithecium, hyaline, not branched, flexuose, hyaline or brownish and thick-walled below, sometimes geniculate; asci 8–12, ovate with a short stalk, 64–80 × 36–51 μ; spores 4–5, usually 5, oblong or subcylindrical, 20–34 × 10–14 μ. (Fig. 2.)

ERYSIPHE sp.

On *Populus Simonii*, SHENSI: Paochi, Sept. 29, 1939, *Y. S. Wu 8489*.

A species of *Erysiphe* was collected on *Populus Simonii* at Paochi, Shensi, by Mr. Y. S. Wu in 1939. Unfortunately the plant is immature. It shows the following characters: epiphyllous; mycelium persistent, dense, effused or forming patches; perithecia subgregarious to scattered, cells of the perithecial wall obscure, 150–181 μ in diameter; appendages numerous, basal, tortuous, usually short to one-half as long as the diameter of the perithecium, hyaline; asci 6–12, broadly ovate to subglobose, 53–57 × 33–41 μ; spores not yet delimited.

MICROSPHAERA ALNI (Wallr.) Winter emend. Salmon.

On *Akebia trifoliata*, HONAN: Sunghsien, *Wang 622*. On *Corylus heterophylla*, HONAN: Sunghsien, *Wang 1061*. On *Castanea mollissima*, YUNNAN: Kunming, *6973*; KWEICHOW: Meitan, *7936*. On *Picrasma quassioides*, SHENSI: Sian, *8297*. On *Quercus acutissima*, KWEICHOW: Meitan, C. U. Path. Herb. no. 461; SZECHUAN: Kwanhsien, *Wei 2187*. On *Q. Fabri*, HUNAN: Changsha, *4079*.

There has been much confusion concerning the identity of the species of *Microsphaera* on *Quercus*. Five species have been described from North America, and one from Europe. The writer has made a careful study of all the available collections of the Chinese forms of *Microsphaera* (list of specimens examined not given for limitation of space) that occur on the genus *Quercus*, and found that they are not identical with any of the species so far described on this genus. The appendages of the Chinese forms are usually shorter than or equal to the diameter of the perithecium (sometimes only one-half as long), and the primary branches are usually much longer than those of other orders. One group of the collections has larger perithecia (108–157 μ in diameter) and larger numbers of asci (5–10, rarely 13) than the others so far examined (perithecia 88–120 μ in diameter; asci 3–7). The mycelium, being either amphigenous, epiphyllous, or hypophyllous, and evanescent or persistent, is not a reliable character for differentiation of the different forms. But when all the characters are taken into consideration as a whole, the forms of the two groups above mentioned differ more from one another within the same group than between the two groups in other characters such as the size of ascospore, the length of appendages, etc. The writer is thus inclined to the opinion that the Chinese forms of *Microsphaera* on *Quercus* so far studied had better be referred to *M. Alni* as emended by Salmon.

The mode of branching of *M. Alni* var. *dentatae* (Liou) Tai (Bull. Ch. Bot. Soc. **1**: 22. 1935) is somewhat similar to that of *M. Alni calocladophora* (Atk.) Salm. in that the main axis of the primary branches, not dividing dichotomously at the apex, often grows on and bears sets of opposite branches, but the former differs from the latter in the smaller ascospores, shorter appendages, and more numerous asci. This type of branching is occasionally seen in other forms of *Microsphaera* on *Quercus*.

MICROSPHAERA DECAISNEAE Tai.

Although *M. Decaisneae* (Lingnan Sci. Jour. **18**: 459. 1939) is close to *M. Alni*, it is unique in the few appendages, the uniformly colored basal part of the appendage (one-third or one-half the length from the base) and the larger spores.

Microsphaera berberidicola Tai, sp. nov.

On *Berberis* sp., HONAN: Sunghsien, Oct. 1939, C. S. Wang, *Wang 507*, TYPE.

Amphigena, plerumque epiphylla; mycelio persistente vel subpersistente, effuso; peritheciis dense gregariis vel sparsis, 80–97 μ diametro, cellulis parietis exterioris 7–13 μ latis; appendicibus 6–11, diametro perithecii 1–2.5 longioribus, ramulis, 3–4-, rarius 5- vel 6-dichotomis, ramulis ultimis plerumque recurvatis; ascis 4–7, late ovatis, 50–60 × 34–40 μ, 4–6-sporis; sporidiis ellipsoideis, 18–20 × 10–11 μ.

Amphigenous, chiefly epiphyllous; mycelium persistent to subpersistent, effused or forming patches; perithecia densely gregarious or scattered, cells of the perithecial wall 7–13 μ wide, 80–97 μ in diameter; appendages 6–11, equaling to 2.5 times the diameter of the perithecium, usually slightly exceeding the diameter, 3–4-, rarely 5- or 6-dichotomously branched, flaccid when long, the primary branches usually much longer than those of other orders, divergent, the ultimate branchlets mostly recurved, 7–8 μ wide and thick-walled at base; asci broadly ovate, 50–60 × 34–40 μ, 4–7 in number, usually 5–6; spores 4–6, ellipsoid, 18–20 × 10–11 μ. (Fig. 3.)

The plant is very close to *M. divaricata* in the mode of branching of the appendage and in the number of the same, but differs in the much shorter appendages and larger asci. It is also distinct from *M. lonicerae* in the smaller number of appendages, different mode of branching, longer asci, and smaller spores.

MICROSPHAERA GROSSULARIAE (Wallr.) Lev. ?*M. Sophorae* Gandara, Mem. Acad. Cient. Mex. **26**: 234. 1908. *M. Bidentis* Tai, Lingnan Sci. Jour. **18**: 458. 1939.

Burrill first referred *M. Van-Bruntiana* Gerard (Ell. & Ev. N. Am. Pyren. 24. 1892) to *M. Grossulariae*. This was followed by Salmon in his monograph on the Erysiphaceae (Mem. Torrey Club **9**: 157. 1900). Jaczewski (Karmanni opridielitel gribov. 2 Lieferung: Mehltaupilze 1927), however,

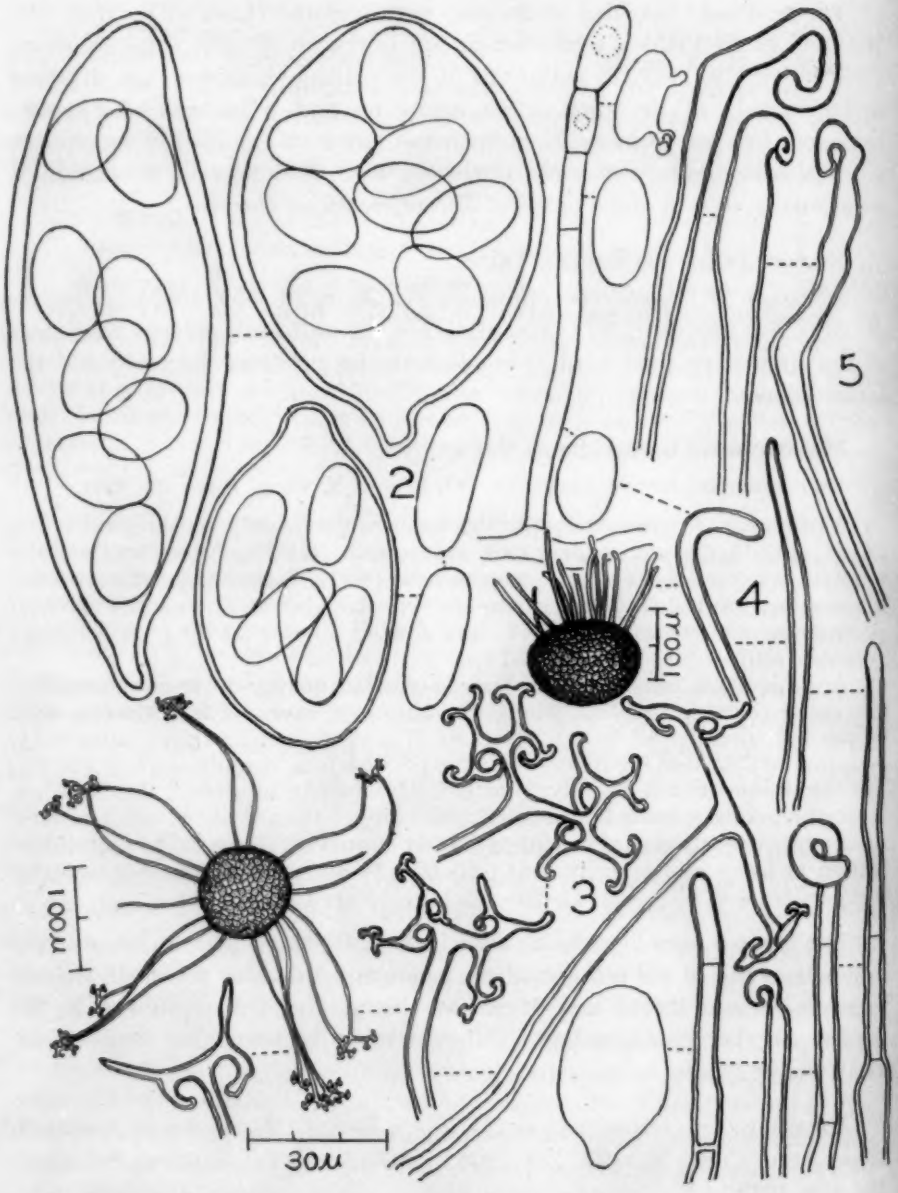


FIG. 1. *Sphaerotheca lanestris* (on *Quercus Delavayi*), 2 asci: the fusiform ascus becoming subglobose after absorbing enough water. FIG. 2. *Erysiphe Polygoni* var. *Epimedii*, 1 ascus and 2 ascospores. FIG. 3. *Microsphaera berberidicola*, 1 perithecium and 4 appendages, showing the mode of branching. FIG. 4. *Uncinula Acalyphae*, 1 perithecium, 4 appendages, 1 ascus; conidiophore and 3 conidia. FIG. 5. *Uncinula Verniciferae* (on *Chionanthus retusa*), 3 appendages.

considered them as distinct species. A careful comparison of the collections listed below of *Microsphaera* on *Bidens, Berberis, Caragana* and *Sambucus* led the writer to the conclusion that they all should be referred to *M. Grossulariae*. He is not sure whether *M. Sophorae* should be considered a synonym of the former, but the forms on *Caragana* and *Berberis* from North China which have referred to *M. Sophorae* (Bull. Ch. Bot. Soc. **2**: 23. 1936), do not differ essentially from *M. Grossulariae*.

The present writer has also studied collections of the forms of *Microsphaera* on *Berberis* and *Sambucus* from Japan. The collections no. 18 and no. 594 ex Herbarium Faculty of Agriculture, Hokkaido Imperial University, on *Berberis amurensis* and *B. vulgaris* respectively, originally labelled as "*Microsphaera Berberidis*," are identical with *M. Grossulariae*. Another collection from Japan on *Berberis Thunbergii*, also labelled as "*M. Berberidis*" is evidently to be referred to *M. divaricata*, since the primary branches are long and divergent and the tips of the ultimate branchlets all recurved.

Specimens examined: On *Sambucus chinensis* (not *Bidens* sp.), SZECHUAN: Kwanhsien, *Wei 2170*. On *S. japonica* KIANGSU: Nanking, *Shen 288*. On *S.* sp., JAPAN, Nov. 1927, *V. M. Chu*. On *Berberis amurensis*, CHAHAR: Shiaowutaishan, Aug. 20, 1934, *L. Shih*. On *B. Poiretti*, CHAHAR: Shiaowutaishan, Aug. 20, 1934, *L. Shih*. On *Caragana chamlagu*, HOPEI: Peiping, Sept. 12, 1934, *C. C. Cheo*. On *Berberis amurensis*, JAPAN: Sapporo, Oct. 3, 1925, *Y. Homma* (no. 18 ex Herbarium Faculty Agr. Hokkaido Imp. Univ.). On *Berberis vulgaris*, JAPAN: Sapporo, Sept. 8, 1921, *Y. Homma* (no. 594 ex Herbarium Faculty Agr. Hokkaido Imp. Univ.). On *B. Thumbergii*, JAPAN: Bot. Gard. Koishikawa, Tokyo, Nov. 29, 1904, *S. Kusano*.

MICROSPHAERA BLASTI Tai.

In a previous publication (Lingnan Sci. Jour. **18**: 458. 1939) the host plant of *Microsphaera Blasti* was given as *Blastus pauciflorus*. This has recently been found to be incorrect; it is *Lindera megaphylla*. Although *M. Blasti* is very close to *M. Benzoinis* (Bull. Ch. Bot. Soc. **1**: 23. 1935) and on a host of the same genus as the latter, yet the former is distinct in the more numerous and much longer appendages, fewer and smaller asci, fewer spores in each ascus, and the different mode of branching of its appendages.

M. Blasti: Appendages 7–15, usually about 10, rarely 2 or 4; 1–2, rarely 2.5 times the diameter of the perithecium, usually 1.5 times; 112–287 μ long, 7.8–8.5(11) μ wide at base; branching lax and irregular, the tips of the ultimate branchlets not all recurved. Asci 3–4, rarely 5 or 6; 42–57 × 30–41 μ; 2–4-spored, usually 3-spored. (Fig. 7.)

M. Benzoinis: Appendages 3–7, usually 4–5, rarely 2 or 11; shorter than or slightly exceeding the diameter of the perithecium, usually shorter; 57–86(100) μ long, 7–8.5 μ wide at base; branching close and regular, the ultimate branchlets all distinctly recurved. Asci 4–6, rarely 8; 46–71 × 31–51(56) μ; 3–5-spored, usually 4- rarely 2-spored. (Fig. 8.)

Microsphaera Robiniae Tai, sp. nov.

On *Robinia pseudoacacia*, KANSU: Tiensuei, Oct. 10, 1943, W. L. Hsian, *Hsian 197*, TYPE.

Amphigena, plerumque epiphylla; mycelio persistente, effuso; peritheciis dense gregariis, 119–146 μ diametro, cellulis parietis exterioris 10–15 μ latis; appendicibus 9–25, diametro perithecii 1–2 longioribus, flexuosis vel geniculatis, membrana ad basim crassi, hyalinis, saepe brunneolis, 1-septatis, ramulis 3–5 dichotomis, ramulis ultimis non recurvatis; ascis 6–13, ovatis vel ovato-oblongis, brevissime stipitatis, 64–73 × 29–36 μ, 4–7-sporis; sporidiis ovoideis, 17–20 × 11–13 μ.

The branching of the appendages is rather close; primary branches are usually longer than those of other orders, sometimes divergent. This plant shows affinity with *M. Euphorbiae*, but differs in the much shorter appendages, rather close-branching, and the longer asci. It is distinct from *M. Alni* var. *ludens* in the smaller number of appendages, ovate or ovate-oblong asci, and the never recurved ultimate branchlets. It is very close to *M. Umbilici* Kom., but differs in the more numerous and flexuous-contorted or angularly bent appendages and much shorter spores. (Fig. 6.)

UNCINULA CLINTONII Peck.

On *Celtis sinensis*, YUNNAN: Kunming, *4117;* Luliang, *7653;* Kaiyuan, *4128*. On *Firmiana simplex*, KWEICHOW: Meitang, C. U. Path. Herb. No. 648. On *Paulownia tomentosa*, SZECHUAN: Chingtan, *8490*.

The form on *Paulownia tomentosa* has the same characters as the others except that the appendages are often abruptly flexuous.

UNCINULA KENJIANA Homma.

On *Ulmus pumila*, HONAN: Sunghsien, *Wang 1293*.

Amphigenous; mycelium evanescent; perithecia subgregarious to scattered; cells of the perithecial wall 10–13 μ wide, 71–90 μ in diameter; appendages 7–14, ¾ to slightly exceeding the diameter of the perithecium, 5.7–6.4 μ wide at base, asperulate up to the apex, enlarged and coiled twice at the apex, thin-walled throughout, hyaline; asci 3–5, broadly ovate or subglobose, 43–57 × 34–47 μ; spores 2, ovoid, 34–37 × 20–23 μ.

UNCINULA DELAVAYI Pat.

On *Cedrela sinensis*, YUNNAN: Kunming, *4118, 4119, 5242, 5243, 7656*.

Amphigenous, chiefly hypophyllous; mycelium evanescent; perithecia subgregarious, 98–151 μ in diameter; cells of the perithecial wall 8.6–16 μ wide; appendages 6–12, rarely 4 or 15, shorter than (⅔), equaling, or slightly exceeding (1⅓) the diameter of the perithecium, short and long on the same perithecium, straight or usually slightly curved, somewhat undulating or geniculate, closely uncinate and wider towards the apex, 7–8.5 μ wide at the base, thin-walled above, thick-walled at the base, smooth; asci 4–10, ovate or ellipsoid, shortly stalked or not, 60–74 × 21–44 μ; spores 6–8, rarely only 5, ovate or ovate-oblong, 20–24 × 10–13 μ (commonly 20 × 11 μ).

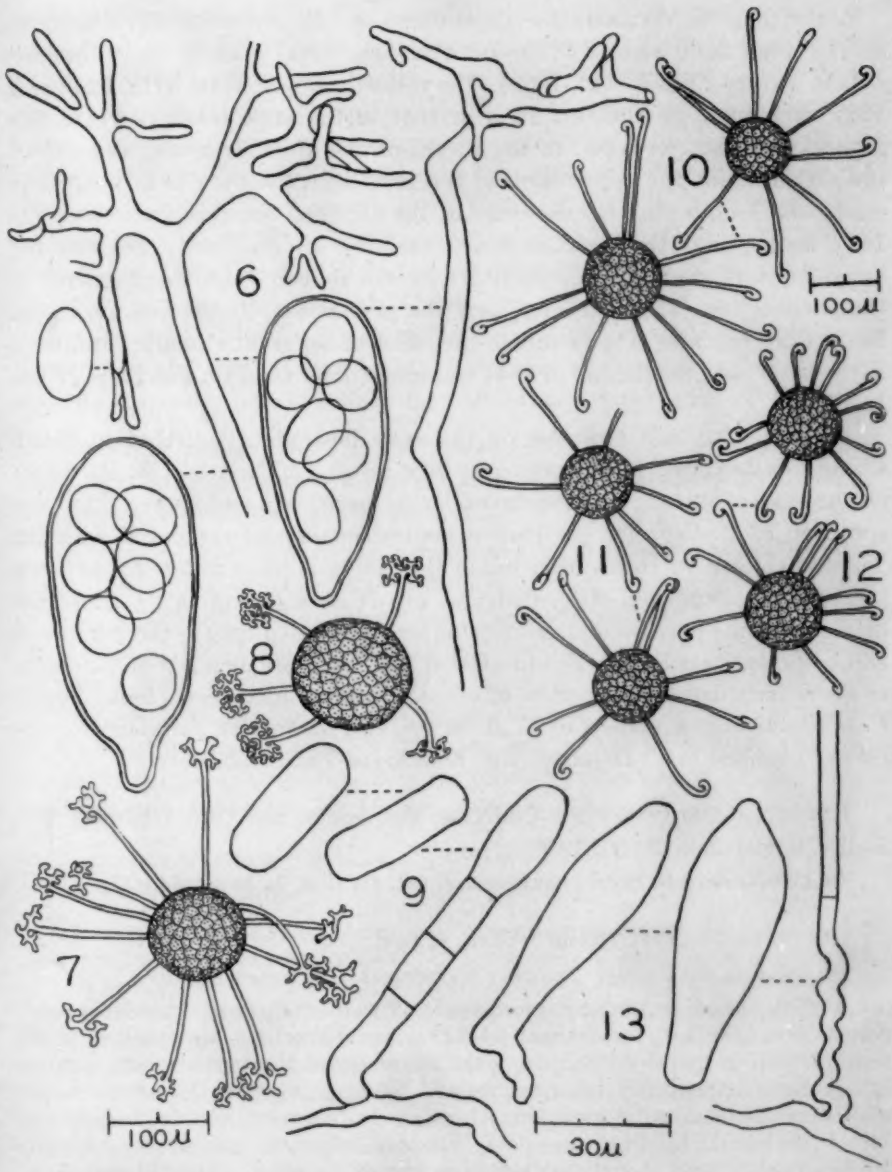


FIG. 6. *Microsphaera Robiniae*, 2 appendages, 2 asci and 1 ascospore. FIG. 7. *Microsphaera Blasti*, 1 perithecium. FIG. 8. *Microsphaera Benzoinis*, 1 perithecium. FIG. 9. *Uncinula yunnanensis*, conidiophore and 2 conidia. FIG. 10. *Uncinula Delavayi* var. *Cedrelae*, 2 perithecia. FIG. 11. *Uncinula Delavayi*, 2 perithecia (collection no. 5243) collected in 1939. FIG. 12. *Uncinula Delavayi*, 2 perithecia (collection no. 7656) collected in 1941. FIG. 13. *Uncinulopsis polychaeta* (on *Pueraria yunnanensis*), part of condiophore showing the spirally twisted basal part, and 2 conidia.

According to Salmon the appendages of *U. Delavayi* are "usually shorter than the diameter of the perithecium, rarely slightly exceeding it" (Mem. Torrey Club **9**: 118. 1900). The collections nos. 4118, 4119, 5242 and 5243 were made in 1939, no. 7656 in 1941 in the same locality. These two gatherings differ, however, in the length of the appendage and the size of the perithecium. The appendages of the 1939 collections are mostly equal to or slightly longer than the diameter of the perithecium, rarely shorter (92–181 μ long), and the perithecia are 98–132 μ in diameter; whereas the appendages of the 1941 collection are mostly shorter than the diameter of the perithecium (71–146 μ long) and the perithecia 100–151 μ in diameter. These differences seem to be due to the effect of different climatic conditions in the two years, for the fall of 1941 was much drier than that of 1939. (Figs. 11, 12.)

In 1936 *Uncinula Cedrelae* on the same host plant collected in North China was described by the writer as new (Bull. Ch. Bot. Soc. **2**: 20. 1936) on the basis of its longer appendages, larger perithecia and spores. The type specimen of *U. Cedrelae* has been examined again and compared with the Yunnan collection. It has been found that there is some difference between them: the appendages of *U. Cedrelae* are from equaling to 2⅓ times the diameter of the perithecium, never shorter (114–310 μ long); the perithecia and ascospores are larger. But in view of the observations made at Kunming as above mentioned on the effect of climatic conditions it seems best to make *U. Cedrelae* only a variety of *U. Delavayi*, and its variety *nodulosae* is also hereby changed to *U. Delavayi* var. **nodulosae** Tai, comb. nov.

UNCINULA DELAVAYI var. **Cedrelae** Tai, comb. nov. *U. Cedrelae* Tai, Bull. Ch. Bot. Soc. **2**: 20. 1936.

On *Cedrela sinensis*, HOPEI: Sanfangshan, Oct. 20, 1934, *L. Shih 1086*. (Fig. 10.)

UNCINULA MIYABEI (Salm.) Sacc. & Syd.

On *Cudrania tricuspidata*, YUNNAN: Kunming, *6886*; Chengkung, *7958*.

Amphigenous; mycelium persistent, effused or forming patches; perithecia gregarious to scattered, 94–111 μ in diameter; appendages 8–20, shorter than or usually 1–1.5 times the diameter of the perithecium, geniculate or flexuous, slightly enlarged toward the apex, thin-walled above, thick-walled at the base and rough, sometimes up to the apex, simply uncinate or loosely helicoid, hyaline; asci 3–7, broadly ovate to subglobose, 42–48 × 30–33 μ, not or very shortly stalked; spores 4–6, rarely 5, ellipsoid or oblong, 19–25 × 11–13 μ.

UNCINULA SALICIS (DC.) Winter. *U. mandshurica* Miura, Flora Manch. & E. Mongolia **3**, Fungi. 1930.

On *Populus Simonii*, HONAN: Sunghsien, *Wang 485a*. On *P.* sp., YUNNAN: Chichushan, *Tali 4130*. On *Salix* sp., SHENSI: Nanwutaishan, Sian, *8491*. On *S. Wallichiana*, YUNNAN: Kunming, *4120*.

This species seems to be very variable in the size of the perithecium and the number of the appendage. The Chinese forms usually have smaller perithecia (about 91–144 μ in diameter) and fewer appendages (about 23–60, sometimes only 18–37). Occasionally, however, forms with comparatively larger perithecia or more numerous appendages have been encountered. For instance, the perithecia of the collection no. 4130 and *Wang 485a* are 114–171 μ and 112–169 μ in diameter respectively. The fungus of the collection no. 4130 has 32 to 80 appendages, usually above 40, rarely only 24, and the Shensi plant 76 to 101. And in certain Chinese forms such as the latter there are only 6 to 8 asci in each perithecium.

Uncinula mandshurica Miura differs from *U. Salicis* mainly in the larger perithecium. In view of the fact that the size of the perithecium is very variable it seems proper to make *U. mandshurica* a synonym of *U. Salicis*.

UNCINULA SEPTATA Salmon. *U. curvispora* Hara, Mycologia **11**: 80. 1917. *Uncinulella curvispora* Hara, Parasitic Fungi of Japan 133. 1936.

On *Quercus Fabri*, HUNAN: Changsha, *4079*.

The writer studied authentic specimens of *Uncinula curvispora* from Japan (on *Fagus japonica*, Kawauyemura, Japan, August 1920, *K. Hara*) and has failed to find it distinct from *U. septata*. In 1917 Hara proposed a new genus, *Asterothecia*, to accommodate the fungus on *Fagus* because the perithecia turn over on their heads at maturity like those of *Phyllactinia Corylea*. In 1936 he changed the genus name to *Uncinulella* putting emphasis this time on the radially arranged cells of the perithecial wall. This kind of structure has been found by the present writer also in *Typhulochaeta* and *Uncinula Koelreuteriae*. Hara's genus is untenable.

UNCINULA SENGOKUI Salmon.

On *Celastrus articulatus*, FUKIEN: Shaowu, *Loh 19,861*.

The occurrence of this species in China was first reported by Miura from Liaoning on *Celastrus articulatus*. It has been collected again on the same host in the province of Fukien by Prof. Loh who has kindly sent the specimens to the writer for study. The characters of the fungus are as follows: amphigenous; mycelium evanescent to subpersistent, effuse or forming patches; perithecia gregarious to scattered, depressed-globose, 106–162 μ in diameter, mostly 119–125 μ; cells of the perithecial wall 7–14 μ wide; appendages 11–30, shorter than, equaling, or slightly exceeding ($\frac{1}{4}$ to $1\frac{1}{3}$) the diameter of the perithecium, short and long on the same perithecium (89–157 μ long, 7–8.5 μ wide at base), thick-walled below, straight or mostly curved, not or slightly enlarged upward, rarely flexuous at lower part, equatorially inserted; asci 9–13, broadly ovate or subglobose, very shortly stalked, 43–47 × 30–36 μ; spores 4–6, ellipsoid, 17–23 × 9–11 μ.

UNCINULA SINENSIS Tai & Wei.

On *Sophora japonica*, HONAN: Sunghsien, *Wang 580*. On ?"*Mallotus*" sp., KWEICHOW: Meitan, C. U. Path. Herb. No. 466.

The Meitan plant agrees closely with *U. sinensis* except that the asci are larger and the mycelium is persistent and dense: epiphyllous; mycelium persistent, dense, effused or forming patches; perithecia gregarious to scattered, cells of the perithecial wall 11–14 μ wide, 111–157 μ in diameter; appendages 9–28, shorter than ($\frac{3}{4}$), equaling, or 1.5 times the diameter of the perithecium, slightly enlarged above but narrowed at the apex, thin-walled, slightly thicker and asperulate at the base, 6–7 μ wide at the base, somewhat undulating; asci 5–8, ovoid to broadly ovate, 63–77 × 40–49 μ, shortly stalked; spores 4–6, usually 5, ellipsoid or oblong, 26–27 × 13–16 μ.

U. sinensis seems to have a wide range of hosts; it has been reported on *Acer, Sophora,* and *Rhus.*

UNCINULA VERNICIFERAE P. Henn.

On *Chionanthus retusa* (Oleaceae), YUNNAN: Kumming, *7763.* On *Cotinus coggyria,* HONAN: Chengpin, *Wang 255.*

The appendages of the plant on *Chionanthus retusa* are mostly enlarged at the upper one-third or one-half but always with narrowed apices. In the typical *U. Verniciferae* the appendages are usually not enlarged, but gradually narrowed upward from the lower two-thirds; some with enlarged middle part or upper one-third, however, also occur. The fungus on *Chionanthus* is considered a form of *U. Verniciferae:* epiphyllous, rarely amphigenous; mycelium persistent, thick, effused; perithecia gregarious or densely gregarious to scattered; cells of the perithecial wall 11–19 μ wide, 86–134 μ in diameter; appendages 11–23, rarely only 9, shorter than or usually equaling to 1.5 times the diameter of the perithecium (85–167 μ long), short and long on the same perithecium, enlarged upward, the broadest part 8.5–11 μ wide, 6–7 μ wide at the base, narrowed at the apex, loosely uncinate or helicoid, thin-walled above, thick-walled and asperulate at lower half, not or 1-septate at the base, the basal cell occasionally brown in color, straight or slightly curved, sometimes flexuous or geniculate; asci 4–6, rarely 3 or 9, broadly ovate or subglobose, 49–57 × 33–42 μ, not or shortly stalked, 6–8, rarely 5-spored; spores ellipsoid or ellipsoid-oblong, 17–20 × 8.5–11 μ. (Fig. 5.)

Uncinula carpinicola Hara was originally described as a variety of *U. geniculata,* the description of which was translated and published in 1917 by Tanaka (Mycologia **11**: 80. 1917). In 1927 Hara raised his new variety to specific rank, and redescribed the fungus as follows (Hara, Diseases of Trees [in Japanese], p. 195. 1927): amphigenous; mycelium thin, effused; perithecia gregarious or scattered, depressed-globose, averaging 100 μ in diameter; cells of the perithecial wall 7–15 μ wide; appendages usually 15–17, slender, thin-walled, colorless, 2–4 times the diameter of the perithecium, geniculate at the middle, narrowed at the apex and helicoid; asci 5–10, obovate or elliptic, 40–45 × 30–35 μ; spores 5–8, elliptic, ovate, or subglobose, 18–25 × 10–12 μ. In 1936 the present writer referred to *U. carpinicola* a species of *Uncinula* collected on *Carpinus Turczaninovii* by the late Mr. L. Shih in North China (Bull. Ch. Bot. Soc. **2**: 19. 1936). That plant, however, differs from *U. carpinicola* in the more numerous and shorter appendages (19–49, usually 30; 1–1½ times the diameter of the perithecium against 16–20, usually 15–17, 2–4 times the diameter of the perithecium in *U. carpinicola*) and the larger perithecium and asci. It accords rather closely with

the fungus on *Chionanthus* and is here also considered as a form of *U. Verniciferae*. *U. carpinicola*, being very close to the former, might prove to be identical on further study.

UNCINULA YUNNANENSIS Tai.

The conidial stage of *U. yunnanensis* has been observed to be as follows: amphigenous; mycelium persistent, forming patches; conidiophores 3-celled, curved at the basal part, 26–40 × 7 μ; conidia solitary, oblong or cylindrical, 30–33 × 11–13 μ. (Fig. 9.)

This species is very close to *U. Ehretiae* except that the perithecium is much smaller. In the original diagnosis of the latter it was not clearly indicated whether the appendages are thin-walled and enlarged near the apex. Wei (Nank. Jour. **11**: 107. 1942) reported a form of *U. Ehretiae* on *Bischofia trifoliata* from Szechuan the perithecium of which is about the same size as that of the typical plant. The appendages of the Szechuan fungus are, however, slender at their apex, and thick-walled at the base. If this be the case in the typical *U. Ehretiae*, then the Yunnan plant should remain a distinct species, as its appendages are always enlarged near the apex and thin-walled throughout. *U. yunnanensis* is tentatively kept separate from *U. Ehretiae* until the type of the latter is studied again.

Keissler (Symb. Sin. **2**: 21. 1937) suggested that *U. Ehretiae* might be identical with *U. aspera* of South Africa. The latter, however, differs from *U. Ehretiae* in the more numerous and much longer appendages.

Uncinula Acalyphae Tai, sp. nov.

On *Acalypha brachystachys*, YUNNAN: Shishan, Kunming, November 1938, *F. L. Tai 4153*, TYPE. *4152, 4155, 5293, 5294, 7603* and *8328*; SZECHUAN: Chengtu, *Ling 131*.

Amphigena; mycelio persistente effuso; peritheciis gregariis, 94–144 μ diametro; cellulis parietis exterioris 7–14 μ latis; appendicibus 24–50, rarius 8 vel 14, diametro perithecii 0.5–1 longis, membrana crassi, non vel 3-septatis, obscure brunneis, ad apicem non vel rare uncinatis; ascis 7–11, anguste vel late ovatis, 39–47 × 20–24 μ, immaturis.

Amphigenous; mycelium persistent, dense, effused; perithecia gregarious, depressed-globose; cells of the perithecial wall 7–14 μ wide, 94–144 μ in diameter; appendages 24–50, usually over 20, rarely only 8 or 14, on the upper half of the perithecium, 0.5 to equaling the diameter of the perithecium, straight or slightly flexuous, thick-walled up to the apex, not or 3-septate, dark brown, paler above, uniform in width, 4–6 μ wide, sometimes slightly tapering toward the apex, straight or slightly curved and blunt at the apex, rarely uncinate or helicoid; asci 7–11, ovate, 39–47 × 20–24 μ, immature. Conidiophore long and slender, 1–4-celled, the basal cell 4–6 times longer than the other cells, 46–113 μ up to 243 μ long, 4.3–7.0 μ wide; conidia solitary, ovoid or ellipsoid, 16–30 × 10–16 μ (21 × 11 μ), with granular contents. (Fig. 4.)

Ascospores are not delimited on all the specimens so far collected even as late as in December nor on overwintered leaves. This species has appen-

dages similar to those of *U. septata* but it has much smaller perithecia and its appendages are rarely uncinate.

UNCINULA NECATOR (Schw.) Burr.

On *Vitis vinifera*, YUNNAN: Kunming, *4099*.

Only the conidial stage was collected: amphigenous, mycelium persistent, dense, effused or forming patches; conidiophores 1–3 celled, 74–143 × 7–8.5 μ; conidia solitary, oblong or ellipsoid, 29–39 × 13–18 μ.

Since 1935 many new species of *Uncinula* have been described from China. In the key to Chinese species of *Uncinula* in a previous publication (Bull. Ch. Bot. Soc. **1**: 28. 1935), *U. Aceris* and *U. Tulasnei* were wrongly placed in the section with thin-walled appendages. That key is hereby corrected and revised to include new species published since them.

KEY TO CHINESE SPECIES OF UNCINULA

1. Appendages colored 2
   Appendages colorless or only colored at base 5
2. Appendages colored throughout the entire length, narrowed toward apex. *U. simulans* Salm.
   Appendages colored for only half of their length 3
3. Appendages crowded on the upper half of the perithecium 4
   Appendages not so; perithecia 70–128 μ in diam. ..... *U. necator* (Schw.) Burr.
4. Perithecia 175–201 μ in diameter; appendages uncinate at their apex. *U. septata* Salm.
   Perithecia 94–144 μ in diameter; appendages rarely uncinate at their apex. *U. Acalyphae* Tai.
5. Asci 2–3 spored 6
   Asci 8 or 4–8 spored 7
6. Perithecia 85–115 μ in diameter; appendages thick-walled at base, close uncinate or helicoid at apex ..... *U. clandestina* Schroet.
   Perithecia 71–93 μ in diameter; appendages thin-walled throughout, uniformly coiled twice at apex ..... *U. Kenjiana* Homma.
7. Asci 8 spored 8
   Asci 4–8 spored 12
8. Appendages some or all bifid or multifid; spores 8, rarely 6 9
   Appendages not so; spores regularly 8 11
9. Mycelium densely compacted; appendages mostly simple ..... *U. Tulasnei* Fuckel.
   Mycelium not densely compacted; all or most of the appendages bifid or multifid 10
10. Appendages 1–2 dichotomously branched; perithecia 120–225 μ in diameter; asci 4–12, 70–95 × 45–55 μ ..... *U. Aceris* (DC.) Sacc.
    Appendages 2–3 dichotomously branched; perianth 232–313 μ in diameter; asci 14–34, 97–109 × 43–52 μ ..... *U. polyfida* Wei.
11. Appendages thin-walled throughout; perithecia 76–105 μ in diameter. *U. Fraxini* Miyabe.
    Appendages thick-walled at base;[5] perithecia 213–312 μ in diameter. *U. nankinensis* Tai.
12. Appendages stout, 7–8 μ wide at the base 13
    Appendages narrower at the base 18
13. Appendages thin-walled, 11–32; perithecia 92–143 μ in diameter. *U. sinensis* Tai et Wei.
    Appendages thick-walled at base 14

[5] When the wall is more than twice the thickness of the wall above.

14. Appendages with colored bulbous base ..... *U. bulbosa* (Tai et Wei) Tai.
Appendages not so 15
15. Appendages 4–12, enlarged upward 16
Appendages 20–36, not or slightly enlarged upward ..... *U. Sengokui* Salm.
16. Appendages regularly nodulose ..... *U. Delavayi* var. *nodulosae* Tai.
Appendages not or occasionally nodulose 17
17. Appendages shorter than or equaling the diameter of the perithecium, rarely slightly exceeding; perithecium smaller ..... *U. Delavayi* Pat.
Appendages 1–2½ times the diameter of the perithecium; perithecium larger. *U. Delavayi* var. *Cedrelae* Tai.
18. Appendages thin-walled 19
Appendages thick-walled at base 22
19. Perithecia 85–175 μ in diameter; appendages 10–150 20
Perithecia 70–90 μ in diameter; appendages 2–9 ..... *U. yunnanensis* Tai.
20. Appendages 10–27, narrowed upward; asci 3–5 ..... *U. australiana* MacAlpine.
Appendages 30–150, slightly enlarged upward; asci 6–14 21
21. Appendages swollen in places; asci 6–8, 47–54 × 31–35 μ. *U. Salicis-gracilistylae* Homma.
Appendages not swollen in places; asci 8–14, 55–80 × 30–40 μ. *U. Salicis* (DC.) Winter.
22. Appendages 4–8, shorter than the diameter of the perithecium ..... *U. Ehretiae* Keissl.
Appendages 6–48, equaling to 2 times the diameter of the perithecium 23
23. Appendages narrowed at apex 24
Appendages enlarged upward or slightly so, not narrowed at apex 25
24. Asci 6–8 spored, rarely 5; spores 15–29 × 8.5–19 μ ..... *U. Verniciferae* P. Henn.
Asci 4–5 spored, sometimes 3 or 6; spores 27–35 × 14–19 μ ..... *U. Mori* Miyake.
25. Appendages more or less angularly bent, not swollen at apex 26
Appendages straight or often more or less undulating, not angularly bent, swollen at apex ..... *U. Clintonii* Peck.
26. Appendages 6–13; asci 50–71 × 38–56 μ ..... *U. Miyabei* var. *Aleuritis* Wei.
Appendages 10–22(48); asci 48–59 × 32–41 μ ..... *U. Miyabei* (Salm.) Sacc. et Syd.

Typhulochaeta Koelreuteriae (Miyake) Tai, comb. nov. *Uncinula Koelreuteriae* Miyake, Bot. Mag. Tokyo **27**: 39. 1913. *Erysiphe Koelreuteriae* (Miyake) Tai, Bull. Ch. Bot. Soc. **2**: 16. 1936.

On *Koelreuteria bipinnata*, HONAN: Chengpin, *Wang 194*.

In the classification of the Erysiphaceae all the students of the group up to the present day, following Léveillé, separate the genera on the basis of the characters of the appendage and the number of asci. On the discovery of endophytic mycelium in *Leveillula taurica* by Salmon in 1906, and in *Uncinulopsis subspiralis* by Sawada in 1916, it is clear that the characters of the appendage alone are not dependable for differentiating genera. Besides the true appendages, there occur in certain species (*Phyllactinia Corylea* and *Uncinula bulbosa*) gelatinous penicillate cells on the upper part of the perithecium; whereas in other species (*Typhulochaeta japonica* and *Uncinula Koelreuteriae*) only the penicillate cells are present. If the characters of these penicillate cells are constant and are correlated with other constant morphological characters, there is no reason why they should not be used as criteria for distinguishing genera. Ito and Hara established the genus *Typhulochaeta* (Bot. Mag. Tokyo **29**: 20. 1915) mainly on the gela-

tinous clavate penicillate cells of their *T. japonica*. Miyake, on the other hand, referred the powdery mildew collected by him at Nankow, China, on *Koelreuteria bipinnata* to the genus *Uncinula* as *U. Koelreuteriae* because some of the penicillate cells are uncinate at their apex. After a careful study of the latter fungus at Peiping, the present writer found that the gelatinous cells occurring on the upper half of the perithecium are similar to the penicillate cells of *Phyllactinia Corylea*, but not comparable in any way to the true non-gelatinous appendages of *Uncinula*. He therefore referred this species to the genus *Erysiphe*, since perithecia with obsolete appendages are not rare in that genus. Clements and Shear (Genera of Fungi 249. 1931) and Wei (Nank. Jour. **11**: 3. 1942) did the same thing by transferring *Typhulochaeta japonica* to *Erysiphe*.

T. japonica was recently collected in this country at *Kwanhsien*, Szechuan (Nank. Jour. **11**: 3. 1942). Through the kindness of Dr. C. T. Wei the writer had the opportunity to make a careful study of that species, and found that it shows close affinity with the fungus on *Koelreuteria*. Both of them lack the true appendages and have a perithecial wall of small cells, 4–11 μ wide. The cells are mostly oblong in shape and are more or less radiately arranged with the smallest cells at the apex and the base, and the largest at the equator. In none of the species of *Erysiphe* has this kind of arrangement of the cells of the perithecial ever been observed nor has the presence of penicillate cells been reported. Although the perithecial wall of *Uncinula septata* also consists of radiately arranged cells, yet the regular uncinate appendages are present. In view of these it seems that for the present the genus *Typhulochaeta* had better be maintained and that the proper disposal of the fungus on *Koelreuteria* is to transfer it to that genus.

TYPHULOCHAETA JAPONICA Ito et Hara. *Erysiphe japonica* (Ito et Hara) Clements & Shear, Gen. Fungi 249. 1931. *Erysiphe japonica* (Ito et Hara) Wei, Nank. Jour. **11**: 3. 1942.

On *Quercus Baroni*,[6] SZECHUAN: Kwanhsien, *Wei 2183*. On *Q. alienta*, SZECHUAN: Kwanhsien, S.P.A.I.I. *122*. On *Q.* sp.,[6] SZECHUAN: Kwanhsien, *Wei 2199*.

The writer found that the spore number of this species is usually 8, rarely 6 or 7. The apical septate and light brown appendages as mentioned by Wei at the top of the perithecium were not observed by the writer.

UNCINULOPSIS POLYCHAETA (B. & C.) Homma emend. Wei. *Uncinula polychaeta* (B. & C.) Ellis, Jour. Myc. **2**: 43. 1886. *Uncinula Shiraiana* P. Hennings, Engl. Jahrb. **29**: 148. 1900. *Phyllactinia Corylea* var. *subspiralis* Salmon, Ann. Myc. **3**: 501. 1905. *Phyllactinia subspiralis* Sawada, Agr. Exp. Sta. Sp. Bull. **9**, 1914. *Uncinulopsis Shiraiana* (P. Henn.) Hara,

[6] These host plants are identified in Wei's paper as *Castanopsis* sp.

Jour. Plant Protection **7** (5). 1920. *Phyllactinia subspiralis* (Salm.) Blumer, Beitr. Kryptogamenfl. Schweiz **7**: 399. 1933.

On *Celtis sinensis*, YUNNAN: Kunming, *4124, 7830;* Hualing, *4123;* I-Liang, *4127;* Tachwang, *4126;* Mengtze, *4125;* Chengkiang, *4129;* KWANGSI: I-shan, C. U. Path. Herb. No. 96. On *Campylotropis polyantha*, YUNNAN: Kunming, *7552*. On *Pueraria yunnanensis*, YUNNAN: Kunming, *7260, 6887*.

The fungus on *Celtis* was described as new by P. Hennings in 1900 under the name of *Uncinula Shiraiana*. It is very close to *U. polychaeta* except that the asci of the latter are usually 2-spored. Salmon (Bull. Torrey Club **27**: 439. 1900) considered *U. Shiraiana* as a synonym of the latter, stating that although the asci of Chinese and Japanese specimens are usually 3-spored, sometimes 2- or 4- or very rarely 5-spored, the occurrence of 3 or 4 spores in the ascus in some American specimens has also been reported by Tracy and Galloway.

A conidial stage of powdery mildew on *Dalbergia Sissoo* with spirally twisted basal part of the conidiophore was discovered in India in 1905 and described by Salmon as a new variety of *Phyllactinia Corylea*, var. *subspiralis*. Basing their disposition on conidial stage only, Sawada in 1914 and Blumer in 1933 raised this variety to specific rank. In 1916 Sawada discovered endophytic mycelium in the fungus on *Celtis* and also its conidial stage of the *subspiralis* type. He then created a new genus, *Uncinulopsis*, to accommodate that fungus and changed *Phyllactinia subspiralis* to *Uncinulopsis subspiralis*. This name was subsequently again changed to *U. Shiraiana* by Hara since P. Hennings' name is the earliest applied to the perithecial stage of the said fungus. Homma (Jour. Fac. Agr. Hokkaido Imp. Univ. **38**: 183–461. 1937) transferred *Uncinula polychaeta* to the genus *Uncinulopsis*, but considered it distinct from *U. Shiraiana*. Wei (Nank. Jour. **11**: 10. 1942), being unaware of this new combination, again transferred *Uncinula polychaeta* to *Uncinulopsis*, including in it the fungus on *Celtis*.

Conidial stage of powdery mildews of the *subspiralis* type on *Pueraria yunnanensis* and *Campylotropis polyantha* has been collected by the writer at Kunming. These host plants have been under observation for two years but no perithecia have ever been produced on them, although the fungus on *Celtis* nearby produces perithecia in great abundance. Then the writer undertook to compare the conidial stage on *Pueraria* and *Campylotropis* with that on *Celtis* to see whether or not they are different. The fungus on *Pueraria* and *Campylotropis* shows the following characters: hypophyllous; mycelium persistent, effused or forming patches; conidiophore 2–4-celled, loosely spirally twisted at the lower part, hyaline, 127–183 × 6–8.6 μ; conidia various in shape, clavate, subcylindrical, fusiform, 51–81 × 16–20(26) μ (broadest part). The conidiophore of the fungus on *Celtis* is 2–5-celled and measures 120–217 × 7 μ; the conidia 57–75 × 14–20 μ. From these measure-

ments it is clear that morphologically the conidial stage of the powdery mildew on *Celtis* does not differ from that of the fungus on *Pueraria* and *Campylotropis*. The fact that the latter does not produce perithecia is due to unknown factors. There are not lacking examples such as *Erysiphe Cichoracearum* which rarely produces perithecia on Cucurbitaceae. Although measurements of conidia and conidiophore were not given by Salmon in his diagnosis of the variety *subspiralis*, yet according to the scale of his illustrations the conidia and conidiophores are about of the same size as those on *Celtis*, *Pueraria*, and *Campylotropis*. (Fig. 13.)

LEVEILLULA TAURICA (Lev.) Arn.

On *Reinwardtia trigyne*, YUNNAN: Kunming, *7224*, *7960*. On *Tropaeolum majus*, YUNNAN: Kunming, *8492*.

Hypophyllous; mycelium persistent, forming definite patches; conidiophores 3–5-celled, 7–9 μ wide, branched; conidia obclavate to subcylindrical, hyaline, 49–90 × 16–18 μ. The conidia of these forms are slightly longer and broader than those usually recorded for this species.

PHYLLACTINIA CORYLEA (Pers.) Karst.

On *Ailanthus altissima*, HUNAN: Yolushan, Changsha, *4081*. On *Alangium platanifolium*, SZECHUAN: Chengtu, *7773*. On *Alnus nepalensis*, YUNNAN: Kunming, *7225*. On *A. cremastogyne*, SZECHUAN: Chengtu, *5302*. On *Broussonetia* sp., HUNAN: Hwanhsien, *4086*. On *Caesalpinia sepiaria*, YUNNAN: Kunming, *8203*. On *Castanea mollissima*, YUNNAN: Chengkung, *4093*; KWEICHOW: Meitan, *7825*; KWANGTUNG: Canton, *4092*. On *Cedrela sinensis*, YUNNAN: Kunming, *7212*. On *Diospyrus Kaki*, YUNNAN: Süanwei, *8025*; Kunming, *5256*. On *D. lotus*, YUNNAN: Kunming, *7239*, *8077*; Chengkiang, *4094*. On *Lindera* sp., HUNAN: Hengshan, *4080*. On *Morus alba*, YUNNAN: Kunming, *7191*, *4088*; Kutsing, *8013*; Chengkiang, *4089*; KWEICHOW: Meitan, *7823*, *7938*; HUNAN: Yolushan, Changsha, *4087*; KWANGTUNG: Canton, *4090*. On *M. australis*, YUNNAN: Kunming, *5259*, *8076*. On *Pterocarya stenoptera*, KWEICHOW: Meitan, *7939*; SZECHUAN: Chengtu, *5306*. On *Principia utilis*, YUNNAN: Kunming, *8153*. On *Pyrus pasha*, YUNNAN: Kunming, *4085*, *7573*. On *P. serotina*, YUNNAN: Kunming, *7253*. On *Quercus alienta*, KWEICHOW: Meitan, *7937*; HUNAN: Hangshan, *4084*.

PHYLLACTINIA SALMONII Blumer.

On *Paulownia tomentosa*, SZECHUAN: Chingtan, Dec. 6, 1939, *C. T. Wei*. On *Actinidia chinensis*, HUNAN: Hengshan, *4083*. On *A. lanata*, KWANGSI: Sankianghsien, *Cheo 2926*. On *A.* sp., KWANGSI: Sankianghsien, *Cheo 2934*.

Hypophyllous or rarely amphigenous; mycelium evanescent to subpersistent, effused or forming patches; perithecia subgregarious to scattered; cells of the perithecial wall obscure, 312–393 μ in diameter; appendages 11–26, slightly exceeding to 1.5 times the diameter of the perithecium, 362–518 μ long, brownish, subhyaline or hyaline; asci 20–24, ovate, ellipsoid, or oblong, with a short stalk, 93–114 × 31–48 μ, 2-spored; spores broadly ovate, 40–46 × 21–24 μ.

The diagnosis of *Phyllactinia Salmonii* as published by Blumer was based on the fungus on *Paulownia imperialis* from Japan. In regard to the

size of perithecium this form is quite isolated from the others of *Phyllactinia Corylea*, the diameter of the perithecium of which reaches only to 288 μ. In addition, the large size of this plant is correlated with a large number of appendages. The form on species of *Actinidia* collected in this country also shows the same characters as that on *Paulownia*. In the writer's opinion *Phyllactinia Salmonii* is a good species.

Phyllactinia imperialis Miyabe is given as the name for the fungus on *Paulownia imperialis* in Hara's "Parasitic Fungi of Japan" (p. 138. 1936); when and where that name was published are not indicated in that book; as far as the writer is aware that name has not been effectively published.

OIDIUM Link.

On *Althaea rosea*, YUNNAN: Kunming, *8493*.

Amphigenous, chiefly epiphyllous; mycelium subpersistent, forming patches; conidiophores perpendicular to the hyphae, 3-celled, 8.3–10 μ wide; conidia elliptic, oblong or cylindrical, 31–43 × 13–18 μ.

On *Artemisia Sieveriana*, YUNNAN: Kunming, *4100*.

On *Berberis Wilsonae*, YUNNAN: Kunming, *4104*.

Amphigenous, mainly epiphyllous. mycelium persistent, effused; conidiophores perpendicular to the hyphae, 1–5-celled, usually 3-celled, 90–113 × 7–9 μ; conidia solitary, sometimes in chains, oblong or cylindrical, 26–49 × 10–15 μ.

On *Castanea mollissima*, YUNNAN: Kunming, *6358*.

On *Cucurbita* sp., YUNNAN: Kunming, *7831*.

On *Fraxinus chinensis*, YUNNAN: Kunming, *7691, 7952*.

On *Lagerstroemia indica*, YUNNAN: Kunming, *4106, 7772, 7907, 7951*.

Amphigenous and caulicolous; mycelium thick, effused, doing great damage to young shoots; conidiophores 2–6-celled, commonly 3, 69–89 × 7–10 μ; conidia solitary, oblong or cylindrical, 24–39 × 11–16 μ (*Uncinula australiana*?).

On *Leucas ciliata*, YUNNAN: Kunming, *7928*.

On *Ligustrum lucidum*, YUNNAN: Kunming, *4108, 5280*.

On *Lycium chinense*, YUNNAN: Kunming, *5278*.

On *Lycopersicum esculentum*, YUNNAN: Kunming, *7950*.

Conidiophores 3-celled, 41–71 × 7–8.6 μ; conidia ovoid or ovate-oblong, 31–41 × 14–16 μ.

On *Malva verticillata*, YUNNAN: Kunming, *4104, 5279*.

On *Medicago sativa*, YUNNAN: Tachwang, *4140*.

Amphigenous; mycelium persistent, effused; conidiophores perpendicular to the hyphae, 68–88 × 5.7–7.1 μ; conidia oblong or cylindrical, 27–34 × 10–14 μ (*Erysiphe Polygoni*?).

On *Mirabilis Jalapa*, YUNNAN: Kunming, *4107, 5285, 5289*.

On *Momordica charantia*, YUNNAN: Tali, *4148*.

On *Oxalis corniculata*, YUNNAN: Kunming, *4105*.

On *Panax pseudo-ginseng*, YUNNAN: Wenshan, *8494*.

Amphigenous; mycelium persistent, forming definite patches; conidiophores 3-celled, 50–87 × 6.4–10 μ; conidia solitary, oblong, 33–37 × 13–17 μ.

On *Quercus* sp., YUNNAN: Kunming, *7833*.

On *Robinia pseudo-acacia*, YUNNAN: Kunming, *4102*.

On *Rubia oncotrica*, YUNNAN: Kunming, *7954*.

On *Siegsbeckia orientalis*, YUNNAN: Kunming, *7949*.

On *Sonchus oleracea*, YUNNAN: Kunming, *7955*.

On *Sophora japonica*, YUNNAN: Kunming, *8495*.

Epiphyllous; mycelium persistent, effused, web-like, radiating from centers; conidiophores 3-celled, 69–74 × 8.6–10 μ; conidia solitary ellipsoid, 26–34 × 14–20 μ.

On *Sophora viciifolia*, YUNNAN: Kunming, *5251*, *5252*, *8032*.

Amphigenous, mainly epiphyllous; mycelium dense and effused; conidiophore 3-celled, 33–84 × 7.1–8.6 μ; conidia solitary, ellipsoid-oblong to subcylindrical, 31–38 × 13–14 μ.

On *Urena lobata*, YUNNAN: Chengkiang, *4097*.

On *Urtica angustifolia* var. *abbreviata*, YUNNAN: Kunming, *7953*.

On *Vicia unijuga*, YUNNAN: Kunming, *5248*, *5249*.

On *Vigna sinensis*, YUNNAN: Kunming, *8496*.

Amphigenous, mainly epiphyllous; mycelium persistent, forming patches; conidiophore 2–3-celled, 70–80 × 13–14 μ; conidia in chains, ovoid with fibrosin bodies, 31–46 × 19–21 μ.

SUMMARY

A careful comparative study has been made of available collections of most of the species of the Erysiphaceae so far reported from China, and it has been found that it seems advisable to keep the collective species: *Erysiphe Cichoracearum*, *E. Polygoni*, and *Microsphaera Alni* as emended by Salmon. Climatic conditions have been found to affect morphological characters in *Uncinula Delavayi* at Kunming. As a result of this study several species have been reduced to synonymy. *Uncinula Koelreuteriae* has been transferred to the genus *Typhulochaeta*. One variety of *Erysiphe*, two species of *Microsphaera* and one variety and one species of *Uncinula* are described as new.

TSING HUA UNIVERSITY
KUNMING, YUNNAN

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 131–133 MARCH, 1946

NOTEWORTHY PLANTS OF TEXAS—V. ADDITIONAL PSORALEAE

B. C. THARP AND FRED A. BARKLEY

One species and two varieties of *Psoralidium* and one species of *Parosela* section *Pogonatherae* occurring in Texas seem to be undescribed.

Psoralidium Youngiae[1] Tharp & Barkley, sp. nov. Herba perennis; caulibus simplicibus subter, ramosis supra, 5–9 dm. altis, canescentibus, strigosis; foliis digitatis, 3–5-foliolatis stipulis lanceolatis, acuminatis, glabris nisi longis-ciliolatis, glandulosis, 1 mm. longis, persistentibus; petiolis 1–2 cm. longis, canescentibus; foliolis 1–3 cm. longis, 3–8 mm. latis, latis-oblanceolatis, glandulosis-punctatis, subglabris nisi ad midvenos supra, subtus canescentibus; pedunculis 4–6 cm. longis; racemis 4–6 cm. longis, floribus multis; bracteis deltoideis-lanceolatis, acuminatis, 1.5–3 mm. longis, glandu-

[1] Mary Sophie Young, daughter of Emma Adams Sainer and Charles Huntington Young, was born in September, 1872, at Glendale, Ohio, the youngest child and only daughter in a family of eight children of an Episcopal minister. She was reared at Glendale, Washington, and Gambin, Ohio. After graduation from Harcourt Place Seminary at Gambin, Ohio, in 1891, she attended Wellesley College until 1895 when she received her A.B. degree. From 1895 to 1897 she was an instructor in Louis Academy at Sullivan, Missouri; from 1897 to 1898 at Dundee (Illinois) High School; from 1898 to 1906 at Grafton Hall, Fond-du-Lac, Wisconsin; and at Waterman Hall, Sycamore, Illinois, during 1907–1908. In 1900 she began graduate work at the University of Chicago during the summer, and in 1906–1907 spent the year there, receiving the S.M. degree. From 1908 to 1910 she continued graduate study there, doing work on the morphology of the Podocarpineae which was published in the Botanical Gazette (50: 81–100. 1910). She received the Ph.D. degree in 1910. In the fall of 1910 she came to the University of Texas as a tutor, became an instructor in 1911 and continued in that capacity until her death on March 5, 1919.

A fine teacher and of generous disposition she soon became one of the inspiring teachers at the University of Texas. Her thoughtfulness and understanding of students was outstanding so that she is still affectionately remembered by them as an example of what the relationship between student and instructor should be.

Coming to the University of Texas when she did she found knowledge of the flora of west Texas very fragmentary, so that the end of the spring semester usually found her alighting from a train in west Texas, accompanied by a student or not, buying a spring wagon, a team of burros, and supplies, and heading into the inaccessible portions of that area, to reappear just before the opening of the fall semester loaded down with plants from the botanically unknown cañons, plains, and mountains. In her short career in the state she established the Herbarium of the University of Texas as a going concern, and left a contribution of exceptionally valuable specimens, duplicates of which were distributed to several of the larger American herbaria. She enigmatically distributed specimens as having been collected by "M. S. Young," and was pleased at having acknowledgements addressed to her as "Dear Sir."

She kept interesting daily accounts of her several collecting trips, which are deposited in the botanical library of the University of Texas. These embody graphic and often humorous accounts of the conditions and experiences encountered in her field work. In a comparatively short career in Texas few people have so inspired a younger generation of workers, or have left so much in the way of valuable permanent scientific data.—University of Texas Herbarium Biographical Sketch VIII. B. C. Tharp & Fred A. Barkley.

losis, sparse strigosis, dense ciliolatis; pedicelis 1–2 mm. longis, longe-hirsutis; calyce 2 mm. longo, glanduloso; lobis subaequalibus, deltoideis, acutis, dense ciliolatis; corolla caerulea, circa 6 mm. longa; vexilla suborbiculari; leguminibus ovatis, proboscide abbreviato.

A perennial with creeping rootstock; stem simple below, branched above 4–9 dm. high, silvery-canescent, strigose, striate, not glandular-dotted; leaves digitately 5-foliolate below, 3-foliolate above; stipules lanceolate, acuminate, glabrous except long-ciliolate, glandular, 1 mm. long, persistent; petioles 1–2 cm. long, striate, canescent; leaflets 1–3 cm. long, 3–8 mm. broad, obovate to broadly oblanceolate, rounded to subacute, glandular-dotted on both surfaces, subglabrous except on the midnerve above, mucro minute, obscured by a tuft of hairs; petiolules about 1 mm. long, densely canescent; peduncles 4–6 cm. long, canescent; racemes 4–6 cm. long, many-flowered; flowers 2–4 at each node; bracts deltoid-lanceolate, acuminate, 1.5–3 mm. long, glandular, sparsely strigose, densely ciliolate with very long hairs; pedicels 1–2 mm. long, long hirsute; calyx 2 mm. long, dark colored, glandular, subglabrous and strigose-canescent in lines; lobes subequal, deltoid, acute, shorter than the tube, densely ciliolate; corolla blue, about 6 mm. long; banner suborbicular; pod ovoid, glabrous, glandular dotted, with short erect beak.

TYPE: Midfield, Texas, April 7, 1939 (II), *B. C. Tharp s.n.* in the University of Texas Herbarium.

This species is closely allied to *P. floribundum* (Nutt.) Rydb., *P. tenuiflorum* (Pursh) Rydb. and *P. obtusilobum* (T. & G.) Rydb. in general aspect. It is more densely canescent, the inflorescence more compact, the ciliation of the calyx-lobes is shorter and denser, the pedicel is shorter than the calyx, and the bracts are shorter and broader.

Besides the typical variety, *Psoralidium linearifolium* (T. & G.) Rydb. is represented in Texas by two varieties:

Psoralidium linearifolium var. **palodurensis** Tharp & Barkley, var. nov. Varietas speciei similis exceptis bracteis lanceolatis, acutis, calycis lobis subacuminatis, floribus majoribus et longius pubescentibus.

Perennial; 4–8 dm. high, striate, with long slender branches; branches sparingly glandular-dotted, sparingly strigose with long white hairs; leaves short-petioled; leaflets 1–3, very short petiolulate, glabrous above, strigose below, glandular-dotted above and below, 3–6 cm. long, 2–3.5 mm. broad; flowers in loose racemes, pedicels slender, 1–1.5 cm. long, bracts lanceolate, acute, glandular-dotted, strigose, 3–5 mm. long, petals 10 mm. long; calyx 6 mm. long, 2.5 mm. broad, strigose, glandular-punctate, calyx lobes densely long-ciliolate, lanceolate, subacuminate.

TYPE: Palo Duro Canyon, Texas, June 15, 1929, *B. C. Tharp 5767* in the University of Texas Herbarium.

Psoralidium linearifolium var. **texensis** Tharp & Barkley, var. nov. Varietas speciei similis exceptis bracteis ovatis, cordatis, calyce obliquo et glandulosissimo, calycis lobis subacutis.

Perennial, 4–8 dm. high, striate, with long slender branches; branches sparingly glandular dotted, strigose; leaves subsessile; leaflets 1–3, very short petiolulate, glabrous above, strigose below, glandular-punctate above and below, 2–5 cm. long, 2–4.5 mm. broad; flowers in loose racemes, pedicels slender, 6–9 mm. long; bracts deltoid-ovate, cordate, acute, glandular-dotted,

strigose, 1–2 mm. long; petals 8 mm. long; calyx 3.5 mm. long, 2 mm. broad, sparsely strigose, densely glandular-punctate, calyx lobes subacute, glabrous except margin densely short-ciliolate.

TYPE: Sherman Lake, Grayson County, Texas, June 15, 1939, *B. C. Tharp s.n.* in the University of Texas Herbarium.

This is the common variety in Texas, although the typical variety enters the state in the northeast corner.

Parosela Walkerae[2] Tharp & Barkley, sp. nov. Herba perennis; radicibus ligneis; caudice ligneo, brevi; caulibus 1–2 dm. altis, gracilibus, sparse minute pubescentibus, sparse glandulosis; foliis 5–25 mm. longis; foliolis 3–11, oblanceolatis, 3–7 mm. longis, glabris; pedunculis circa 2 cm. longa; spicis laxis, 4–5 cm. longis; bracteis late ovatis; longe acuminatis, subter conspicue glanduloso-punctatis, margine plus minusve scarioso; calycis tubo late turbinato, circa 2.5 mm. longo, sericeo; calycis lobis 2.5 mm. longis, subulatis, ad basim triangularibus; corolla purpurea.

A perennial, with a woody root and short caudex; stems 1–2 dm. high, slender, microscopically sparsely puberulent; sparsely glandular; leaves 0.5–2.5 cm. long; stipules subulate, 2 mm. long; rachis margined, glabrous, sparsely glandular-dotted; leaflets 3–11, oblanceolate, broadly cuneate at base, rounded at apex, 3–7 mm. long, glabrous, very sparingly glandular dotted; spikes lax, 4–5 cm. long; bracts broadly ovate, long-acuminate, conspicuously glandular-dotted on the back, somewhat scarious margined; calyx tube broadly turbinate, about 2.5 mm. long, silky-villous; lobes 2.5 mm. long, abruptly subulate from a triangular base; corolla deep purple; pod sparsely villous above, densely long villous on the margins.

TYPE: La Joya, Hildalgo County, February 2, 1942, *Mrs. E. J. Walker s.n.*, in the University of Texas Herbarium.

The inflorescence of *P. Walkerae* is lax and interrupted much as it is in *P. enneandra* (Nutt.) Britt. but the corolla is a deep purple. The habit, calyx and bract are most similar to that of *P. pogonathera* (A. Gray) Vail. The calyx-lobes are abruptly subulate and about the length of the calyx-tube as contrasted with the larger calyx of *P. pogonathera*, whose abruptly subulate calyx-lobes are from one and one-half times to twice as long as the tube. *P. lasianthera* (A. Gray) A. Heller has calyx-lobes broad at the base, gradually tapering to subulate tips, the lobes much shorter than the tube.

THE HERBARIUM, DEPARTMENT OF BOTANY AND BACTERIOLOGY,
UNIVERSITY OF TEXAS
AUSTIN, TEXAS

[2] Thelma, daughter of Mr. & Mrs. E. D. Rateliff, born at Kingman, Indiana, on December 20, 1908, married E. J. Walker on April 24, 1930. In 1909 moved to the Rio Grande Valley (Starr County, Texas) where she lived until she married except for the first four grades of school at McAllen. Her home is now at La Joya. Since 1933 she has collected many specimens of flowering plants which have gone into the S. M. Tracy Herbarium, The Gray Herbarium of Harvard University, and the University of Texas Herbarium. Her color portraits of native flowers show unusual skill in technical painting. She is eminently deserving of recognition for the many interesting plants and extensions of range which her collections in the Rio Grande Area have made available for study.—University of Texas Herbarium Biographical Sketch IX. B. C. Tharp & Fred A. Barkley.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 134–154 MARCH, 1946

TYPES OF ANTHESIS IN HEMEROCALLIS AND THEIR HEREDITY IN F_1 HYBRIDS

A. B. STOUT

It has been recognized and discussed at some length (Stout 1933; 1934) that in species of *Hemerocallis* there are three main types of anthesis: (1) the diurnal or day-blooming, (2) the nocturnal or night-blooming, and (3) the extended blooming. For some time it has been evident to the writer that there are further distinctions in the periods of anthesis of the sets of flowers of daylilies and that special methods in the analysis, description and representation of the time-intervals of anthesis are desirable in respect to evaluations (a) of the antheses of the successive sets of flowers under different conditions of weather, (b) of the behavior that can be considered characteristic of species and hybrids, and (c) of the heredity of the different types of anthesis in hybridization. It is to be noted that this paper is primarily concerned with the nature and character of anthesis and not with the calendar dates or season when flowering occurs.

METHODS OF OBTAINING AND PRESENTING DATA

In daylilies an individual flower is open during only one period, in the condition known as anthesis. The many flowers of a plant mature in a rhythmic succession of groups or sets and the flowers of each set have antheses that are synchronous. One may obtain data for an entire set of flowers and speak of the collective antheses as the anthesis of the set. When two or more individuals, especially of a species or of a progeny of known parentage, are uniform in flower behavior, or nearly so, their synchronized antheses may be treated collectively as an anthesis of the entire group. Also the data for different antheses during an entire period of flowering may be combined in ways that provide an evaluation of the fundamental character of what may be called the anthesis of an individual, a clone, a group of sister hybrids, or a population of a species.

In collecting the data here reported it was the aim to make observations on each individual or each group of plants at intervals of not more than three hours during the entire period of the anthesis of a single set of flowers and to obtain such data from a number of different sets during the season of flowering. To facilitate the collection of the data during the night several scapes were cut in the late afternoon of plants growing in the experimental garden at The New York Botanical Garden. These were put in pails with the stems in water and transported by auto to the author's home where they were

placed on an open veranda. Under careful handling the flowers of such scapes closed or opened with normal regularity for observations between 6:00 P.M. of that evening and 6:00 A.M. of the next morning. Usually the flower behavior was then observed for the same plants in the experimental plots not later than 9:00 A.M. Flowers, in considerable number, of each set were labeled with marking tags of different colors and numbers in a way that made certain the identification and the records of successive sets of flowers. This procedure was especially necessary when there was overlap of sets, interpolation of a set, or a delay in the development and anthesis of a set of flowers. Unless otherwise stated all of the data presented in this paper including that of the figures were collected during 1941.

Anthograms.[1] The diagrams shown in the figures acompanying this article were devised by the writer to present graphically the essential features of the different types of antheses in *Hemerocallis*.

The data for the anthesis of any single set of flowers produced by an individual or by two or more individuals that are reasonably uniform may be used in constructing a diagram which may be called an *s-anthogram*. Such diagrams may be oriented in a chart according to the clock hours of daylight and darkness. Then the base line of an s-anthogram indicates the time-interval between the beginning of anthesis and its conclusion, and the upper line of the diagram indicates the time-interval during which the flowers were fully open. In figure 1 the entire body of the s-anthograms is blocked solidly in black, but in figures 2 and 3 the s-anthograms are much flattened.

The data for any number of antheses of an individual plant or of a number of plants which have the same or very similar flowering behavior may be combined and represented in a composite diagram here designated a *c-anthogram*. Such a diagram (see figures 1 and 4) indicates the extremes in the time of opening and closing of all sets of flowers that were observed on an individual plant, on a group of ramets of a clone, or on a number of individuals of the same species or progeny. The four points from left to right in the base line indicate the earliest (*1*) and the latest (*2*) inception of anthesis; and the earliest (*3*) and the latest time (*4*) of the completion of anthesis for all the sets of flowers observed. The four points in the upper line of the c-anthogram indicate the earliest time (*a*) and the latest time (*b*) of full anthesis; and the earliest time (*c*) and the latest time (*d*) when flowers began to close. The body of a c-anthogram between points *b* and *c* is blocked-in in black and this section indicates the time-interval during which flowers were widely open on every day of the observations. Thus the *b–c* interval indicated by the section in black is common to all sets observed and it is an important value for comparisons. The numbers and letters applied

[1] The term anthogram was suggested to the writer by Dr. Harold W. Rickett.

to the time-points of c-anthograms are indicated for two c-anthograms of figure 1 and for one c-anthogram of figure 4.

The two kinds of anthograms as here constructed are distinctly different in appearance (fig. 1). They present rather graphically the values for those features of anthesis that are characteristic of species, of groups of individuals of a hybrid progeny, or of members of a clone. When they are coordinated according to the hours of the day, as in figures 1–4, evaluations and comparisons of the character of the various anthesis are simplified. It is to

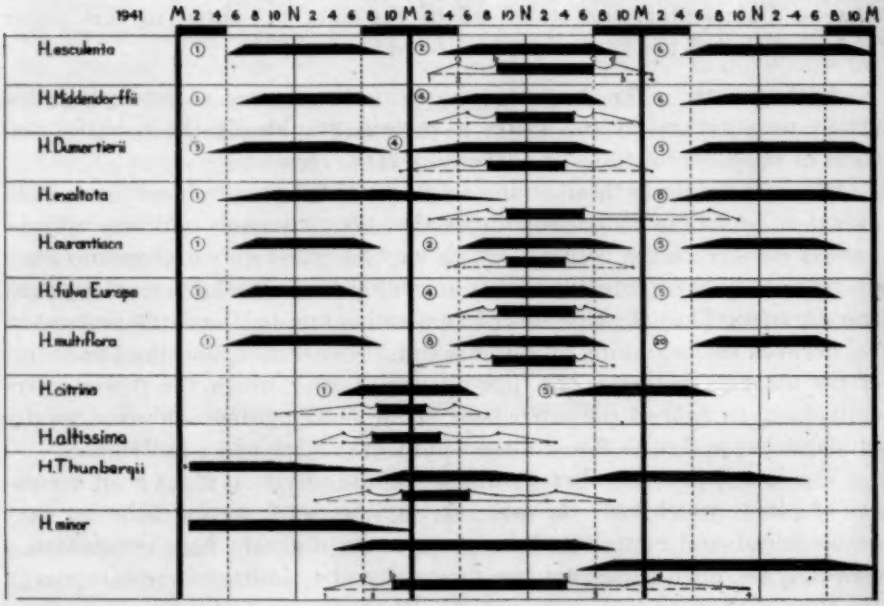


FIG. 1. Typical s-anthograms (entirely in black) and c-anthograms (with 8 time-points as indicated under *H. esculenta* and *H. minor*) for 11 species of *Hemerocallis*.

be noted that the anthograms which are oriented according to hours of a day in the vertical columns of these tables are not for the same calendar day and also that the two or three s-anthograms in the same level are not necessarily for successive days.

DAY-BLOOMING SPECIES

The first seven sections in figure 1 are for daylilies that have diurnal anthesis. Of each of these except the clones of "*H. aurantiaca*" and *H. fulva* clone *Europa* there was available for observations a considerable number of ramets of different clones, or of seedlings, or of both seedlings and clones. Yet there was remarkable uniformity within the numbers of each group with respect to the flower behavior of any anthesis.

In figure 1 the two or three s-anthograms that are given for each species are representative but usually they do not indicate the extremes of the variations in anthesis that were observed and which are indicated in the c-anthogram.

Members of the species *H. esculenta, H. Middendorffii,* and *H. Dumortierii,* of the day-blooming species, flower early in spring. *H. exaltata, H. aurantiaca,* and *H. fulva* clone *Europa* flower in midsummer. Members of the species *H. multiflora* collectively flower in late summer and autumn. Hence the diurnal habit is well distributed over the entire growing season.

Survey of Diurnal Anthesis. The anthograms presented in figure 1 for the seven day-blooming daylilies, and especially the c-anthograms, show that the end-points of all the *common intervals* (*b–c*) fall between 8:00 A.M. and 7:00 P.M. and that the mid-points in the antheses fall somewhat after 12:00 noon except for *H. Dumortierii.* There are definite and specific differences in various features of diurnal anthesis.

In the region about New York City *H. fulva* clone *Europa* blooms in midsummer and shows slight variation in *a–b, c–d,* and *1–2* and *3–4* time-points and intervals. The distinctive clonal name "Europa Daylily" was given (Stout 1929) to the clone that has long been grown in Europe, and to Linnaeus and many other botanists and gardeners it was the only plant of *H. fulva* which was known. Kerner and Oliver (1895) published a list of species which have ephemeral flowers that open once only for a part of a day. The period of anthesis for flowers of "*Hemerocallis fulva*" is given as 14 hours, the time of opening between 8:00 to 9:00 A.M. and the time of closing at 4:00 to 5:00 P.M. But in another table it is stated that at Upsala, Sweden, the flowers of *H. fulva* open at 5:00 A.M. and close at 7:00 to 8:00 P.M., while at Innsbruck, Austria, they open between 6:00 and 7:00 A.M. and close between 8:00 and 9:00 P.M. It is stated that in the famous floral clock constructed by Linnaeus plants of *H. fulva* were included for the closing hour of 7:00 to 8:00 P.M.

The Europa Daylily is widely grown in Europe and America over a rather wide range in latitude and variations are to be expected in respect to calendar dates of flowering and to responses of anthesis under different temperatures and periods of daylight. Dr. Hamilton P. Traub has reported to the author by letter during 1944 that at Salinas, California, the flowers of the Europa Daylily "last not only two days but several days due to the cold weather that slows up growth and senescence." At New York during thirty-three years of observation the writer has never observed in any flowers of this daylily the extension of an anthesis into the hours of a second period of daylight.

H. aurantiaca, also a clone, which blooms with the Europa Daylily has somewhat shorter anthesis, as shown by the value of *b–c,* but more variation in opening and closing (see values for *a–b, c–d,* and *3–4*).

The data for the group of seedlings of *H. exaltata*, also summer-flowering, show much irregularity in time of closing. Occasionally in cool and rainy weather the flowers remain widely open throughout the night following a rather normal day-blooming. The latest time-point for full opening (*d*) was 7:00 A.M.; and the earliest complete closing (*3*) was 1:00 P.M. Thus the anthesis of the plants of *H. exaltata* is definitely day-blooming in regard to the common period (*b–c*) but it is more extended into the hours of darkness than in any other of the day-blooming species that were studied.

The three species *H. esculenta*, *H. Middendorffii*, and *H. Dumortierii* flower early in spring, usually during May. These are quite alike in anthesis. *H. Dumortierii* is somewhat more variable in the intervals of opening and closing, but its common period of anthesis is more balanced in reference to mid-day.

The three s-anthograms for *H. multiflora* are for the original plants obtained from China and some 75 of their seedlings, and they are for the 1st, the 8th, and the 20th day of the observations. But no data were taken for the more delayed opening and closing that frequently occurs in plants of this species after the first week in September. Otherwise for this species the time-intervals of opening are more extended and irregular than are the intervals of closing.

For all the day-blooming species that were studied the common intervals *b–c* were definitely diurnal and in no case was there an overlap at any time of two sets of flowers that were fully open.

Other day-blooming species besides those reported above include *H. nana*, *H. Forrestii*, and *H. littorea*. Of the first two of these, there have been few plants and flowers for study. Of the so-called *H. littorea* there are numerous clonal propagations of a plant obtained from Japan and a considerable number of its selfed seedlings. The flowers of these are definitely day-blooming during warm sunny days throughout the earlier portion of the blooming period but during the cool weather of late September and October the anthesis is often delayed, extended, and irregular; and frequently all flowers of a set remain only partly open.

It may be noted that all the day-blooming daylilies discussed above have either clear orange or fulvous-red flower coloring. It may be noted, however, that *H. coreana* (Nakai 1932), which is described as yellow-flowered, is reported by Hara (1941) to have "yellow diurnal flowers."

THE NIGHT-BLOOMING SPECIES

Of the named species which have nocturnal anthesis only two are definitely known to the writer and data for these are presented in figure 1. Both have flowers that are pale yellow and odorous.

H. citrina. Of this species there were ramets obtained from Italy, which

are believed to be divisions of the plant described as the type of this species, and also seedlings grown from seeds that were collected in the wild in China. In 1941 the combined period of bloom for these was from June 24 to July 30. Two rather typical s-anthograms are shown in figure 1 and the c-anthogram combines all of the observations made on the antheses of these plants in 1941. The *b–c* interval for these plants extended over about five hours of darkness with the median points near 11:00 P.M. In only two sets did the flowers start to open earlier than 3:00 P.M., and the earliest time-point for full opening was at 7:00 P.M. Certain of the unnamed wild night-blooming day-lilies which the writer has obtained from the Orient do not conform closely to the robust plants to which the name *H. citrina* was first given. Especially do some of these have smaller flowers and more narrow leaves. Hara has given two new specific names (*Hemerocallis yezoensis*, 1938; *H. vespertina*, 1941) to collections that had been classed as *H. citrina*, and he states that plants of *H. vespertina* are night-blooming.

H. altissima. Of the species named *H. altissima* (Stout 1943) the type and co-type plants and numerous of their seedlings have been studied. The collective blooming period of these much-branched plants has extended from the middle of July until late in October, but no data on the anthesis were collected after September 10. In the observations that were made the *b–c* interval for this rather large group was a duration of seven hours with its median point at 11:30 P.M. Hence the anthesis is definitely nocturnal in character. During autumn when there are often cool nights the flowers may remain widely open until 9:00 A.M. and on some days they are not fully closed until 3:00 P.M.

A comparison of the c-anthograms of these two night-blooming species shows a difference of two hours in the extent of the *b–c* interval; the time-points of opening are more extended in *H. citrina;* and the time-points of closing are more extended in *H. altissima*. But these contrasts may be due to the differences in the temperatures of summer and autumn. For both species the common interval (*b–c*) was completely nocturnal, and there was no overlap at any time of two sets of flowers that were fully open.

SPECIES WITH EXTENDED ANTHESIS

1. **The Semi-Extended Anthesis of Hemerocallis Thunbergii.** Of this species there were available for study ramets of the clone propagated under this name in England since 1867, a few of the seedlings derived from these by controlled pollination, and also plants of this type that were obtained directly from the Orient.

The c-anthogram compiled from a considerable number of s-anthograms and a large number of observations for a part of the day shows that the common interval for the widely open condition extended from 11:00 P.M.

to 6:00 A.M.; hence this feature of anthesis is definitely nocturnal. But during the cooler days of midsummer the full anthesis of sets of flowers may continue until 3:00 P.M. of the following period of daylight. The earliest hour for complete closing was 2:00 P.M. and the latest was 8:00 P.M. But during most of the interval of closing (*c–4*, from 6:00 A.M. to 9:00 P.M.) the flowers were often wilting and fading and more or less unsightly.

The flowers of these plants do not open early enough to make a good showing during the late afternoon. During the hours of the forenoon in hot weather they are sometimes fading and wilting. In the afternoon a set may be closed as early as 2:00 P.M. and if the closing is later the flowers are usually unsightly. The c-anthogram for *H. Thunbergii* shows that the latest hour of full anthesis was 3:00 P.M. and the earliest hour for this time-interval (*a*) was about 7:30 A.M. Thus there was no overlap of two sets in full anthesis.

No data are given in figure 4 for the anthesis of F_1 hybrids which have plants of *H. Thunbergii* for a parent. In all of the progenies of these hybrids that were studied and also in progenies of intra-specific breeding there were variations of the anthesis of sister F_1 hybrids during a single day of as much as several hours in the time-points. It is considered that at least some of the plants of *H. Thunbergii* for which data are here shown are somewhat heterozygous in respect to the heredity of anthesis. There were, however, no appreciable variations in the anthesis on any one day among the plants included in this particular study.

The plants of *H. Thunbergii* which are included in this report have an anthesis that is chiefly nocturnal with an extension of the time-points of closing (*c–d* and *3–4*) into the following hours of sunlight. This extension is promoted by cool temperatures which, during the period of flowering, usually accompany rainy or cloudy weather.

Several collections of *Hemerocallis* obtained from the Orient are somewhat similar to the type of *H. Thunbergii* in the character of the flowers but are different in having taller and more branched scapes and differences in foliage. The species *Hemerocallis yezoensis* (Hara 1938) is described as more like *H. Thunbergii* than *H. citrina*, and as having flowers that are night-blooming but which remain open during the following forenoon.

2. **The More Extended Anthesis of H. minor.** Of this species there were studied ramets of several clones that have been cultivated in Europe and seedlings grown from their seeds. Since 1941 several collections of seeds from wild plants in Northern China have been grown which are to be included in *H. minor*. The entire normal period of first-flowering for this group especially studied in 1941 extended from May 1 to June 27. There is also a second-period of blooming by numerous plants which extends into the autumn, but special data on anthesis were not obtained for such flowers.

Observations were made on the anthesis of sixteen different sets during the period of first flowering. The s-anthograms or parts of them that are shown clearly indicate that an extended anthesis is normal for these plants. The time interval *1–3* was 28 hours and that of *2–3* was 23 hours, hence the shortest complete anthesis observed was somewhere between 23 and 28 hours. The common interval *b–c* was 18 hours and it extended from 10:00 P.M. until 4:00 P.M. of the following day. After 3:00 P.M. there was much overlap of two successive sets but it was only between 7:00 P.M. and 1:00 A.M. that both sets were ever widely open at the same time.

The time-intervals of the inception of anthesis of *H. minor* were definitely nocturnal and they show slight fluctuation. The anthesis is extended to as late as 1:00 A.M. of the next period of darkness, but there is much fluctuation in closing and often the flowers fade and wilt.

It may be noted that a scape of *H. minor* with an open flower and buds is illustrated in plate 18 of the Somoku-Dzusetsu (Iinuma 1874). A translation of the text supplied to the writer by Professor T. Maekawa states that "the flower begins to open after sunset and begins to close after sunrise and wilts in the forenoon. Therefore the people say 'Yun-Suge' meaning Evening Daylily. Another name for this plant is 'Matsu-yoi-gusa' which means 'waiting-evening-herb.'" Other Japanese publications note that the flowers of this species are night-blooming with some extension into the following period of daylight.

A comparison of the anthesis of *H. minor* with that of *H. Thunbergii* may be made as follows. The antheses of these two species are very similar in being nocturnal in inception and somewhat similar in the range of variations in closing. There is considerable wilting and fading of the flowers of both. But the extension of anthesis is much greater in *H. minor* and more completely a combination of nocturnal and diurnal periods.

3. **The Much Extended and Sensitive Anthesis of H. flava.** The studies here reported are entirely for the ramets of a clone that has long been grown in Europe and America under the common name "Lemon Daylily." This clone is the historical type on which Linnaeus bestowed the name *Hemerocallis flava,* and he evidently knew no other yellow-flowered plant of *Hemerocallis.* Many live plants of yellow-flowered members of *Hemerocallis* have come directly to The New York Botanical Garden from the Orient and also seeds have come from which numerous seedlings have been grown to maturity. Also the writer has examined herbarium specimens of collections of wild plants of *Hemerocallis* at Edinburgh, London, and New York. Not one of all these plants or specimens can correctly be assigned to the Linnaean type of *H. flava.* For a discussion of this matter reference may be made to an earlier publication (Stout 1935). Of the other clones of daylilies in cultivation in Europe which the writer has seen only one is noticeably similar to

the Lemon Daylily. Its flowers are smaller, the foliage is more upright, and the capsules are different in size and shape. But in color of flowers, habits of the growth of foliage and of rhizomes, season of flowering, and flower behavior the two clones are very similar.

For the observations during the one flowering season in 1941, at least 100 well-grown clusters of this one clone of the Lemon Daylily were available at The New York Botanical Garden, in my own home garden, and in the gardens of three of my neighbors. Rather complete records were obtained,

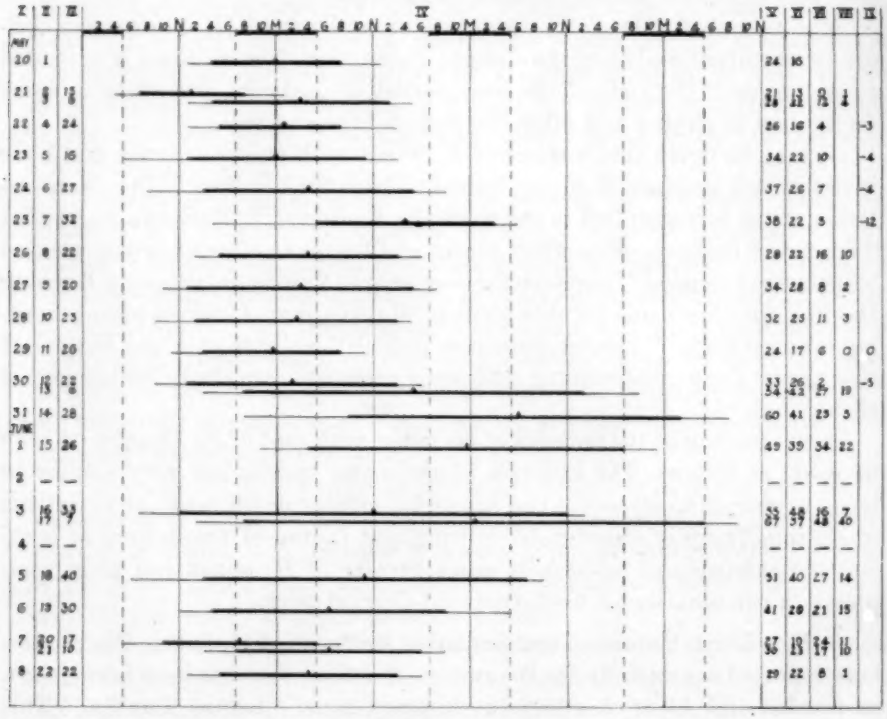


FIG. 2. Data and s-anthograms for 22 consecutive sets of flowers of the clone known as *Hemerocallis flava*.

often with observations at one-hour intervals, for the entire antheses of 22 consecutive sets of flowers which opened between May 20 and June 8 inclusive. The entire period of flowering for the group of plants was from May 12 to June 14, but during the first week and the last week of flowering there were relatively few flowers open.

In figure 2 the s-anthograms are more flattened than in figure 1. The intervals of full opening is represented by the heavier portion and the time-intervals of opening and closing are shown by narrow extensions. Each s-anthogram with its time-points is placed according to the hours of the day

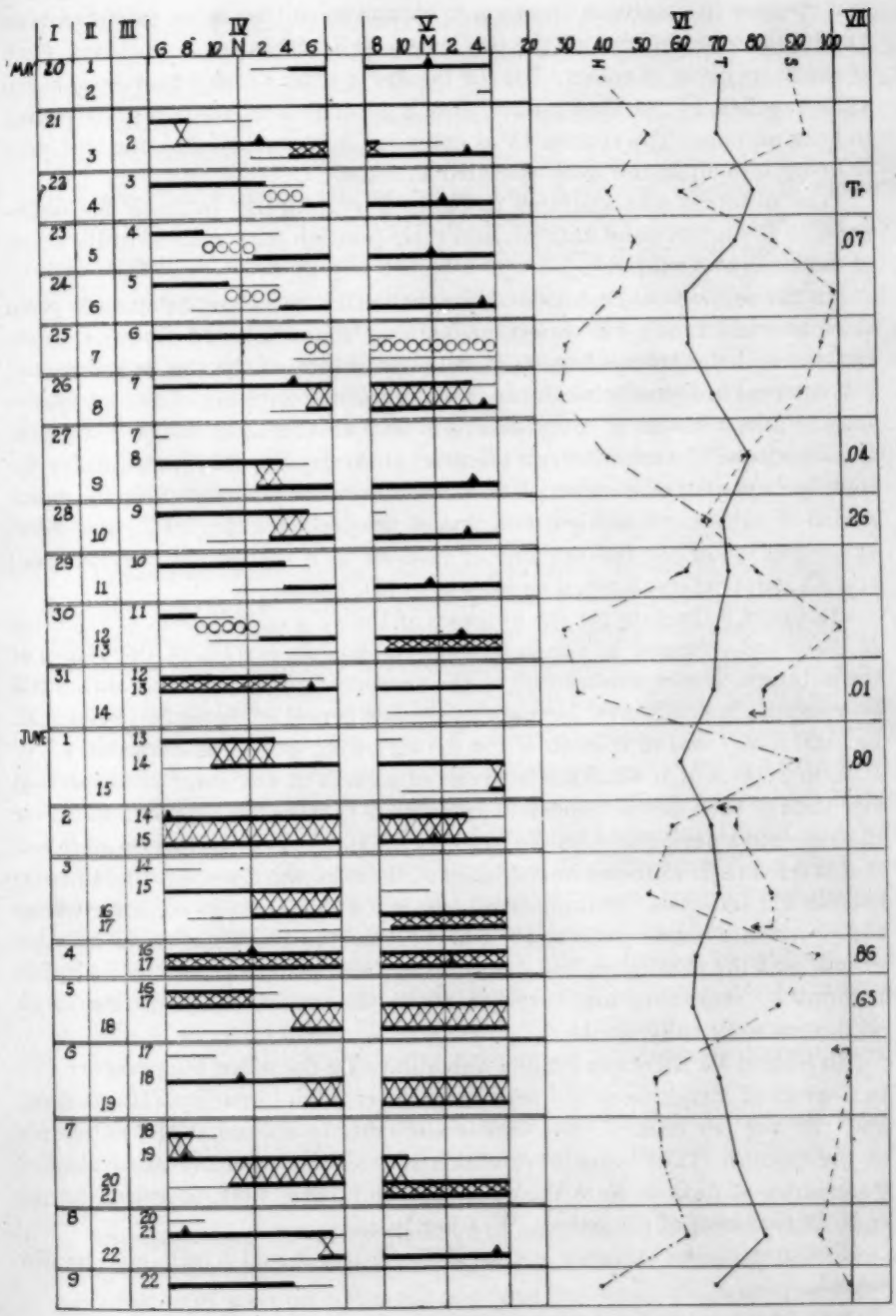


FIG. 3. Data for the antheses of flowers of *Hemerocallis flava*. Explanation in text.

and they are in succession from top to bottom according to the calendar dates (midnight to midnight) of the day when each anthesis was initiated. Each of the dates given in column I is for the day during which an anthesis began and in section IV the time-points of each set of flowers are placed according to hour and day. The section IV is extended to cover two and one-half days in order to include the most extended anthesis.

The different s-anthograms in figure 2 graphically indicate the differences in the intervals of anthesis and their position with respect to the hours of darkness and sunlight.

In the columns at each side of the section IV in figure 2 there are given the numerical values for important features of anthesis as follows: I, calendar dates when antheses began; II, number of each of the sets in succession; III, interval in hours between the inception of the antheses of two successive sets; IV, distribution of intervals of anthesis according to hours of daylight and darkness; V, time-intervals of entire anthesis; VI, time-intervals for the complete opening of each set; VII, time-interval of the overlap in the entire period of anthesis of each set with that of the previous one; VIII, time-interval of overlap of the full opening of each set with that of the previous one; and IX, time-intervals when no set was in full bloom.

In figure 3 the data for the antheses of the 22 sets of flowers of the clone *H. flava* are arranged in a manner that emphasizes certain of the values of the antheses. The representation of the character of the different antheses is coordinated in column IV for each successive period of daylight (5:00 A.M. to 7:00 P.M.) and in column V for the following period of darkness (7:00 P.M. to 5:00 A.M.). Thus the behavior of all sets in any stage of anthesis at any time of each day is indicated. In column I, there are calendar dates for the successive period of daylight; II lists the number of the one or more sets that started their antheses during each of the successive periods of 24 hours; column III indicates the number of each set whose anthesis continued from the previous 24-hour period; IV and V show the coordination of s-anthograms, and the overlap in the condition of full opening of two or more sets is shown by cross-hatching. Circles indicate the time-intervals during which no flowers were fully open.

In section VI there are graphs which indicate the mean temperature (T) in degrees of Fahrenheit, the percentage of relative humidity (H) at noon, and (S) the per cent of the possible sunlight. In column VII are records of the rainfall. These data were obtained from the Monthly Meterological Summaries of data at New York for May and June, 1941, prepared by the U. S. Department of Commerce, Weather Bureau.

Features of the antheses indicated in figures 2 and 3 will now be discussed.

Inception of Anthesis. This was decidedly diurnal; all of its time-points fell between 4:00 A.M. and 10:00 P.M., and 16 of the 22 were between 8:00

A.M. and 4:00 P. M. For 10 sets the inception was between 1:00 P.M. and 4:00 P.M. Even the interpolated sets (Nos. 3, 13, 17, 21) and the sets (Nos. 33 and 40) that followed a day during which no set started anthesis all had points of the inception of anthesis that fell within the range of those sets that were in regular sequence.

Time-Points of the Beginning of Full Anthesis. For 17 of the sets studied this time-point fell between noon and 8:00 P.M., inclusive. The time most typical for the inception of full anthesis was in the afternoon.

Extent of Antheses. The intervals of entire anthesis (start to finish) ranged from 21 to 67 hours with an average of 37+ (fig. 2, column V); the interval of complete opening varied from 13 to 57 hours with an average of 28 (fig. 2, column VI). The anthesis was definitely more extended than that of the plants which were studied of *H. minor*.

Molisch (1938) records that the longevity of flowers of *Hemerocallis flava* is 6 days. But at The New York Botanical Garden no anthesis of more than 72 hours (Stout 1933) has been observed on this daylily.

Disposition of Anthesis. As noted already, the inception of anthesis is definitely diurnal with its time-points most frequent in the afternoon. The most typical disposition of anthesis is that it continues throughout the night and well into the following hours of sunlight.

Overlap of Different Sets. The intervals of an overlap of sets that were widely open are indicated in figure 3 by cross-hatching while circles indicate the time when there were no flowers *widely* open. Values in hours for the overlap of a set with the previous set are given in figure 2; column VII for entire overlap; VIII for overlap of flowers fully open; and IX for no overlap of flowers that were fully open. There were 15 different periods when there was an overlap of two sets and the extent of these ranged from one to 40 hours. There was only one period of two hours when three sets were fully open together. Thus the conditions which give extension of sets with delay in completion of anthesis definitely inhibit and delay the development and anthesis of the next set of flowers.

In case of overlap the flowers of a new set are for a time paler in color than are the flowers of the older set (Stout 1933, 1934).

There was no time during which there were no flowers in some stage of opening, but there were five different periods of from 3 to 12 hours when there were no flowers fully open.

Interpolation. The interpolation of an extra set of flowers was observed. Of the sets 2 and 3 the latter may be regarded as an extra set for there was no omission of a set on either the previous day or on the following one. The same condition was seen for the sets 12 and 13 and for the sets 20 and 21.

Omission of a Set. But the two sets (16 and 17) which started anthesis close together on June 3 were preceded and followed by the only two *omissions* observed. But reference to figure 3 will show that on both these days there were two sets in extended and full anthesis. The time-interval between the inception of two successive sets may be extended to as much as 40 hours. Between the closing of a set and the start of opening of the next set after an omission there was always an overlap (see anthograms for 15, 16, and 17; and 17 and 18 in figure 3).

Influences of Temperature, Humidity and Sunlight. That the conditions just mentioned affect various features of anthesis is obvious and certain to one who observes anthesis in daylilies from day to day. It is to be recognized that these external influences operate to affect the internal processes of growth, differentiation, and development of flowers. In the daylilies that have branched inflorescences, as does the Lemon Daylily, most of the flowers are on secondary laterals which develop in bostryxes (Stout 1941) after the primary flowers have bloomed. There is much growth and development in each bostryx of the inflorescence after flowering begins. There will often be two or more flowers open on a scape at the same time but seldom in a single bostryx. Especially in the later part of the blooming period there will be omissions in the daily maturity of at least one flower of a scape. But the omission of an entire set during the season of heavy bloom, as was observed in *H. flava,* involves a synchronous and systemic condition in all scapes of the various ramets of a clone.

High temperatures, clear sunny days, and dry weather all combine to shorten the period of anthesis and to advance the inception into the hours of the forenoon. These conditions existed for a few days before May 20 and continued while sets 1 and 2 had antheses of 24 and 21 hours. Also an interpolated set (No. 3) occurred during this time. The first noticeably delayed set (No. 7) followed a drop in temperature.

On May 30 there was an interpolated set (No. 13) which had a much extended anthesis, as had the following two sets. On the 30th the temperature was rather high and it remained quite uniform but there was a decrease in sunlight and a rise in humidity. The day was hot, cloudy and "muggy."

The weather conditions which extend anthesis also check or delay the development of the next set of flowers. The anthesis of the interpolated set 13 was much extended over that of set 12 and the antheses of sets 14 and 15 which followed were both delayed and extended during a period of rainy weather. Sets 14 and 15 were in full and extended antheses during June 2 and there was a delay which became an omission for the day of a new set. But on June 3 the next two sets (16 and 17) began anthesis only seven hours apart. Then there was heavy rain and cloudiness with moderate temperatures on the 4th, during which sets 16 and 17 continued in extended anthesis with

overlaps of 57 and 48 hours, and again there was an omission of a new set. Bright sunlight and rising temperature brought sets 20 and 21 into an interpolation and an overlap on each other and on set 19; and from 7:00 to 9:00 P.M. on June 7 there were 3 different sets of flowers widely open. Then there was a shift to shorter periods of anthesis (20, 21, and 22) that were more like those (Nos. 1–11) of the early part of the period of flowering.

The climax in both the extension of the anthesis and the day by day variations in anthesis is seen in the Lemon Daylily. There are wide variations in the length of anthesis, in the precise hours of its duration, and in the location of all the time-points. The variations in the different sets of flowers during a season of flowering reveal a sensitiveness to environmental influences that surpasses all other species thus far studied. But on any one day the flowers of each of the sets of the numerous ramets of the clone in a locality will be alike in a remarkable degree of synchronism.

The retarded, delayed, extended, and interpolated reactions of antheses must, it would seem, indicate physiological conditions in the plant that are more or less localized in the individual scapes.

In regard to the character and the degree of the extended anthesis, the three types *H. Thunbergii, H. minor,* and *H. flava* show marked differences or specificity. All three have an anthesis that is decidedly nocturnal. For *H. Thunbergii* the extension of anthesis into the following period of daylight is irregular from day to day as shown by the long interval of *c–d*. For *H. minor* the extension of anthesis into the following period of daylight is greater than that of *H. Thunbergii* as shown in the position of the *c* time-point at 4:00 P.M. For *H. flava* the extension of anthesis is still greater.

THE ANTHESES OF F_1 HYBRIDS

In most of the twelve groups of the F_1 hybrids included in this report there were at least ten individuals in good bloom and in some there were as many as fifty. With respect to the anthesis of their flowers the members of each of these groups were remarkably uniform on any one day of blooming.

The c-anthograms for these groups of hybrids combine observations of several sets at intervals of from three to four hours and also numerous observations during parts of different antheses. There has not been opportunity since these data were obtained in 1941 to make somewhat continuous observations over a series of days, as was done for *H. flava,* for hybrids and their parents which are in flower on the same days.

The c-anthograms of figure 4 are, it is certain, very accurate in indicating the value of the *b–c* interval, the extent of the various antheses, and the fluctuations in time-points for each group of hybrids. It is certain that more complete data for more sets of flowers could *not reduce* the time-intervals of opening and closing or make greater the *b–c* value, and these are the features of special importance in the evaluations.

Hybrids of Parents That Have Diurnal Anthesis. The first six c-anthograms from the top in figure 4 are for F_1 hybrids of species that have diurnal anthesis. In all cases these F_1 hybrids also had diurnal anthesis, but when comparisons with the parents are made there are some differences to be noted.

1. *H. esculenta* × *H. aurantiaca.* Series 2113. For this series the *1–4* interval was somewhat more extended than was the corresponding period in the seed parent, and it was still more extended than that of the pollen parent. As shown in the c-anthogram the common *b–c* interval was reduced to only 3 hours and the *a–b*, *c–d*, and 3–4 intervals were somewhat extended. Hence

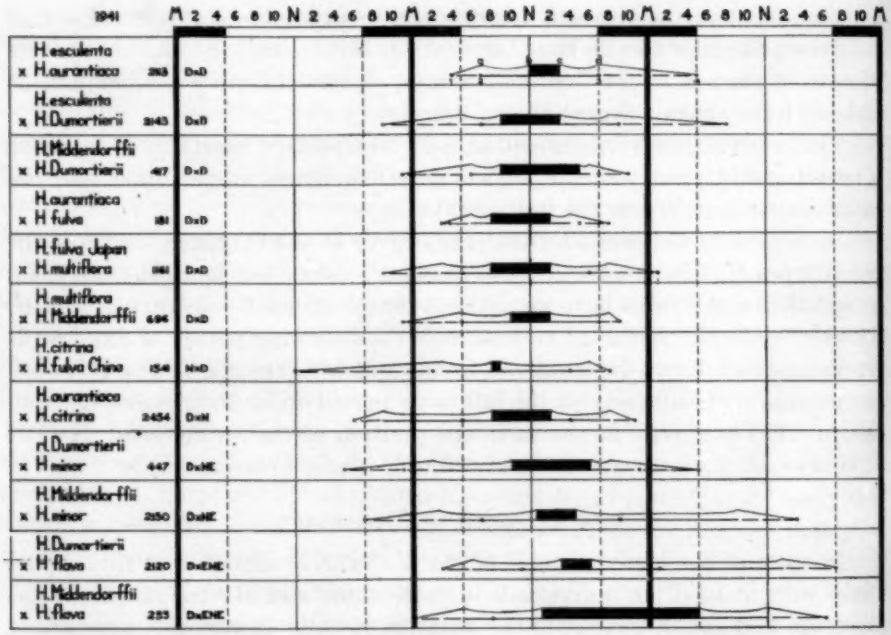

1941
M 2 4 6 8 10 N 2 4 6 8 10 M 2 4 6 8 10 N 2 4 6 8 10 M 2 4 6 8 10 N 2 4 6 8 10 M
H.esculenta x H.aurantiaca 2113 D×D
H.esculenta x H.Dumortierii 2143 D×D
H.Middendorffii x H.Dumortierii 417 D×D
H.aurantiaca x H.fulva 181 D×D
H.fulva Japan x H.multiflora 1141 D×D
H.multiflora x H.Middendorffii 494 D×D
H.citrina x H.fulva China 154 N×D
H.aurantiaca x H.citrina 2454 D×N
H.Dumortierii x H.minor 447 D×NE
H.Middendorffii x H.minor 2150 D×NE
H.Dumortierii x H.flava 2120 D×ENE
H.Middendorffii x H.flava 253 D×ENE

FIG. 4. C-anthograms for 12 groups of F_1 hybrids of *Hemerocallis.*

these F_1 hybrids were more variable than were the respective parents under the day by day changes in the environmental factors that affect flower opening.

2. *H. esculenta* × *H. Dumortierii.* Series 2143. The c-anthogram for these hybrids shows in comparison with the two parents slight reduction in the intervals for *b–c* and only slight differences in the location of the points *a* and *d*, but there is a noticeable extension of the interval 3–4.

3. *H. Middendorffii* × *H. Dumortierii.* Series 417. The c-anthogram for this group of hybrids is noticeably similar to those of the two parents. The *b–c* interval is not reduced; but the *a–b* and *c–d* intervals are somewhat shorter.

4. *H. aurantiaca* × *H. fulva* Europa. Series 181. There are only very slight differences between the c-anthograms of this group and those of its two parents. The diurnal antheses of the parents and the group of hybrids were quite alike.

5. *H. fulva* "Japan" × *H. multiflora.* Series 1161. The seed parent is diurnal in anthesis but only few observations have been made on the time-points and the intervals. In comparison to the *H. multiflora* this group of hybrids had a shorter *b–c* interval but longer intervals for all other values.

6. *H. multiflora* × *H. Middendorffii.* Series 696. The anthesis of these hybrids shows decided decrease in the *b–c* interval and considerable increase in the intervals *a–b* and *c–d*. Thus there was greater variability from day to day during the season of flowering than was seen in the antheses of the two parents.

F_1 Hybrids Which Have One Parent That Has Diurnal Anthesis and One Parent That Has Nocturnal Anthesis.

7. *H. citrina* × *H. fulva* var. *rosea* clone "Rosalind." Series 1541. Twenty-five hybrids of this parentage were grown during several years. They were remarkably uniform in stature, habits of growth, flower coloring, season of bloom, and anthesis. The data which are compiled in the c-anthograms shown in figure 4 were obtained from four of these hybrids. The observations were made between June 30 and July 16 during the time when both parents were also in bloom. The data collected were complete for ten different sets of flowers, and on each day of the observations only very slight differences were observed in the antheses of these four plants.

The anthesis was diurnal in that the hours of the *a–d* interval ranged between 3:00 A.M. and 6:00 P.M. and the latest time-point for the fully closed condition was at 8:00 P.M. Yet the anthesis was nocturnal in that no set started to open (point *2*) later than 2:00 A.M. It was the rule that the flowers opened slowly and that the time-intervals of the opening of flowers (*1–2* and *1–a*) were extended. In its extent, the interval *1–4* of the c-anthogram for these hybrids includes almost *all of the combined 1–4 intervals of the two parents.*

Thus the antheses of these hybrids show the influence of both parents. The diurnal parent has somewhat greater influence especially if one considers the position of the *a–d* interval. But the variations from day to day were increased to the degree that there was only *one hour* (8:00 to 9:00 A.M.) during which flowers were widely open *on every day* of the observations. It is also to be noted that this time-period (*b–c*) was shifted to mid-forenoon which is an intermediate position with respect to the mid-points of the *b–c* intervals of nocturnal and diurnal antheses.

In somewhat casual observations throughout the blooming period one

would be likely to conclude that these particular hybrids have a diurnal anthesis and that the diurnal habit is dominant to the nocturnal habit. That this is not the case is shown by the decidedly nocturnal inception of anthesis and the greater variability of the hybrids. They are much more sensitive to variations that occur from day to day in temperature and sunlight than is either of the parents. Part of the time their anthesis was more like that of the nocturnal parent and part of the time it was more like the diurnal parent. The interplay of these two heredities reduced the *b–c* interval to one hour and the longest *a–c* interval to six hours. But all the time the influence of the nocturnal parent is evident in the inception of anthesis while that of the diurnal parent is most evident in the time-period (*a–d*) of complete opening.

8. *H. aurantiaca* × *H. citrina*. Series 2454. There were two series of these hybrids and a total of 28 individuals. Observations were made on the complete anthesis of *one* large well-grown plant during the hours of daylight on each of 11 different days between July 3 and July 15. Also data were recorded for all the other sister plants during ten of these days. For these F_1 hybrids there were wide differences in habit of growth and color of flowers, characters for which the clone *H. aurantiaca* is heterozygous, but there was remarkable uniformity in their anthesis. However, the c-anthogram given in figure 4 is for *one* individual that appeared to be representative of the group.

For this hybrid the *b–c* interval of the c-anthogram was decidedly diurnal (8:00 A.M. to 2:00 P.M.) but it was earlier in its time-range than was this interval for *H. aurantiaca* (10:00 A.M. to 4:00 P.M.). The *d* and the *4* time-points were very close to those in the behavior of *H. aurantiaca*, but the *1* point was ten hours earlier.

In the anthesis of these F_1 hybrids the diurnal habit is somewhat evident but there is an extension of anthesis into the preceding nocturnal period. There is greater variation from day to day than was observed in either parent. The hybrids of *H. aurantiaca* × *H. citrina* show less variation from day to day than do the hybrids of *H. citrina* × *H. fulva* clone "Rosalind," reported in the preceding paragraphs, but there is much the same combination of nocturnal and diurnal features.

F_1 Hybrids Which Have One Parent with Diurnal Anthesis and One Parent with Extended Anthesis.

9. *H. Dumortierii* × *H. minor*. Series 477. The anthesis of these hybrids was decidedly diurnal in respect to the *b–c* interval. In its extent this interval of 8 hours was the same as that of the diurnal parent but it was much shorter than that of the *H. minor*. But the time-points for inception of anthesis (*1* and *2*) fall at 5:00 P.M. and 7:00 P.M. which are close to the location of these time-points in the antheses of *H. minor*.

In regard to the start of the opening of their flowers these hybrids were nocturnal quite like *H. minor*, but the complete opening was delayed until

its completion was definitely diurnal in character. The *2–4* time-interval was 24 hours in extent and its time-points came almost at midnight. Thus there was much increase in the extent of anthesis over that of *H. Dumortierii*. There was however no overlap of two sets fully open.

10. *H. Middendorffii* × *H. minor*. Series 2150. The c-anthogram for these hybrids shows a *b–c* interval of only 4 hours that extends from 12:30 P.M. to 4:30 P.M. This is definitely diurnal and reflects an influence of the *H. Middendorffii* parent.

But the preceding *a–b* interval covered 10 hours and the following *c–d* interval was one of 16½ hours. Hence there was a noticeable extension of the time-interval when some flowers were fully open. The overlap of two sets fully open was rather frequent between 5:00 A.M. and 9:00 A.M. These extensions show an influence of the *H. minor* parent. The much shorter value of *b–c* in the hybrids indicates that the day by day antheses of the hybrids were much more variable than those of either parent. There was remarkable uniformity in the antheses of the various members of the hybrid group on any one day but the hybrids were more sensitive to the daily alternations of daylight and darkness than was either of the two parents.

The antheses of the two species *H. Dumortierii* and *H. Middendorffii* are quite similar (see figure 1) but the antheses of the two groups of hybrids obtained when they are crossed with the one species *H. minor* are noticeably different.

11. *H. Dumortierii* × *H. flava*. Series 2120. In these hybrids the inception of anthesis, the position of the *a* time-point, and the position of the *b–c* time-intervals were all diurnal; but there was marked extension of the anthesis as seen in its *1–4* and *a–d* time-intervals. These included a diurnal, the following nocturnal, and another diurnal period,—an extent of 30 hours. The combined periods of antheses of the hybrids was somewhat shorter in extent than the longest anthesis of a single set of the *H. flava*. It is certain, however, that the variations in the hybrids are less in degree than are those in *H. flava* as evaluated by the various time-intervals but much greater than those of the diurnal parent.

The inception of anthesis is decidedly diurnal in both parents, and this is the case in the hybrids. The time-intervals of the extent of anthesis (*1–4* and *a–d*) are much greater than those of *H. Dumortierii* but less than those of *H. flava*. In the hybrids the overlap of sets was most frequent in the forenoon.

The overlap of two sets between 10:00 A.M. and 2:00 P.M. has been illustrated in photographs (Stout 1934) of the flowers of the "Gold Dust Daylily," one of the early horticultural clones of the F_1 hybrids of *H. Dumortierii* and *H. flava*.

12. *H. Middendorffii* × *H. flava*. Series 255. These particular F_1 hybrids were very uniform in flower behavior, habit of growth, and character of flowers. Only five of a rather large progeny were kept and these were large well-grown plants with numerous flowers when this study of anthesis was made.

These hybrids had the longest common interval of full anthesis (*b–c*) observed thus far in any group of hybrids or in any species except *H. minor* and *H. flava*. This period (*b–c*) extended from 1:00 P.M. to 5:00 P.M. of the following day. The *a–d* interval extended to 31 hours, from 5:00 A.M. until noon of the following day, and there was frequently an overlap in the antheses of two sets of flowers during the forenoon.

In comparison with the hybrids of *H. Dumortierii* × *H. flava* there was almost the same extent (*1–4*) of anthesis, but there was much less fluctuation in the time-points of closing (*c–d*) and a much longer interval (*b–c*) of common full anthesis.

SUMMARY AND CONCLUDING REMARKS

1. **Specificities of Anthesis.** (a) Among the relatively few species of the genus *Hemerocallis* there are three distinctly different main types of anthesis which are characteristic hereditary specificities. As far as is known the majority of the species have diurnal anthesis, and the flowers of all these are clear orange or fulvous red in color. Two species have nocturnal anthesis, and these have pale yellow flowers which are odorous. Three species have extended anthesis, but to different degrees, and these have yellow flowers which are odorous. Flowering periods of diurnal species are distributed over the entire season of spring, summer, late summer, and early autumn. Of the two nocturnal species, one flowers in midsummer and one in late summer and early autumn. Two that have most extended anthesis (*H. minor* and *H. flava*) bloom in spring at the same time that certain diurnal species bloom, and one (*H. Thunbergii*) flowers in midsummer. Thus the types of anthesis are specificity characters that are not differentiated according to a particular season in the collective period of flowering.

(b) The diurnal and the nocturnal habits of anthesis in *Hemerocallis* exhibit sharp contrasts and specific differentiation. There is no overlap of the time intervals of common full anthesis (*b–c*) of these two types. In the diurnal type the processes which bring about the climax of flower maturity and the action of the mechanism of anthesis operate in a synchronized relation with the hours of daylight; in the nocturnal type they are synchronized with the hours of darkness. Temperature, and perhaps humidity, as well as sunlight exert noticeable influence on various features of the expression of anthesis.

(c) The extended type of anthesis combines various features of both the

diurnal and the nocturnal habits. The three species that were studied exhibit different and definitely progressive degrees in the extensions of anthesis.

H. Thunbergii has an anthesis that is primarily nocturnal and there is poor opening and much irregularity during the extension into a part of the following diurnal period.

The anthesis of *H. minor* is also nocturnal at the start but is more stabilized in a greater extension into the following period of daylight.

The anthesis of *H. flava* has the most extended anthesis thus far observed in the species of daylilies; but there is much variation in the antheses of the various sets of flowers. The anthesis is somewhat diurnal in its beginning and more than half of the sets attain full opening in the hours of the afternoon. But the majority of the sets continue in anthesis throughout the following hours of darkness and through at least a part of the second period of sunlight. There are wide variations in the time periods of anthesis.

Thus the *initiation* of extended anthesis is strongly nocturnal in two species and strongly diurnal in one species. The conclusion of the extended anthesis is not closely correlated with the next period in the alternation of daylight and darkness. The time-points of closing are especially fluctuating in response to those variations in weather which have relatively little effect on the anthesis of diurnal species. Also the conditions which induce extreme extensions of anthesis in *H. flava* also retard the development and maturity of the next set of flowers. Thus when two extended sets are widely open during a second period of daylight there is usually an omission of a new set for that day.

2. **Summary of the Heredity of Anthesis in F_1 Hybrids.** (a) It is the general rule that the F_1 hybrids of *Hemerocallis* tend strongly to have features of diurnal anthesis. But there is also, in every case, definite influence of the genom derived from a parent that has either nocturnal or extended anthesis. Thus there are features of both types of anthesis with somewhat noticeable modifications of each.

(b) The F_1 hybrids of diurnal × diurnal parentage have diurnal anthesis. But there is some evidence that such hybrids are often somewhat more variable and less stabilized in the reactions of the inception and the completion of anthesis.

(c) The F_1 hybrids of diurnal × nocturnal parentage have an anthesis that is strongly diurnal. But both of the different genoms exert influence and no anthesis of a set is precisely like that of either parent for that same day. Also the hybrids are more sensitive and variable from day to day. The composite time-intervals for inception (*1–2* and *a–b*) and completion (*c–d*) of anthesis show greater range of variability and in one group of hybrids these variations reduced the *b–c* period to only one hour.

(d) The behavior of four groups of F_1 hybrids of combinations of two

diurnal species and two of extended habit indicates that neither type of anthesis is fully dominant, but that the influence of each parent may be recognized. The anthesis is strongly diurnal in inception, but is less so for hybrids of *H. minor* than for hybrids of *H. flava*.

For the hybrids which have *H. minor* for a parent there was extended anthesis nearly equal to that of *H. minor*, but there was much greater variation especially in the opening of flowers.

The two groups of hybrids which have *H. flava* for a parent had anthesis that was diurnal in the inception and more extended than that of the diurnal parent but less extended that *H. flava*. There was a somewhat unexpected difference in the variability of the two groups of hybrids, although the two diurnal parents were rather similar in anthesis.

The New York Botanical Garden
New York

Literature Cited

Hara, Hiroshi. 1938. Observationes ad plantas Asiae orientalis (XVI). Jour. Jap. Bot. **14**: 25–32.

———. 1941. Observationes ad plantas Asiae orientalis (XVIII). Jour. Jap. Bot. **18**: 119–129.

Iinuma, Yokusai. 1874. Somoku-Dzusetsu. ed. 3. vol. 6, revised by Makino, 1907.

Kerner, Anton von Marilaun. 1895. The natural history of plants. Half-volume III. Translation by F. W. Oliver.

Molisch, Hans. 1938. The longevity of plants. Translation by Edmund H. Fulling.

Nakai, T. 1932. *Hemerocallis* japonica. Bot. Mag. [Tokyo] **46**: 111–126.

Stout, A. B. 1929. The fulvous daylilies—I. Jour. N. Y. Bot. Gard. **30**: 129–136.

———. 1933. The flowering habits of daylilies. Jour. N. Y. Bot. Gard. **34**: 25–32.

———. 1934. Daylilies.

———. 1935. The lemon daylily (*Hemerocallis flava* L.): its origin and status. Jour. N. Y. Bot. Gard. **36**: 61–68.

———. 1941. The inflorescence in *Hemerocallis*—I. Bull. Torrey Club **68**: 305–316.

———. 1943. *Hemerocallis altissima*, sp. nov. Herbertia **9**: 103–106.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 155–166 MARCH, 1946

THE MOSSES OF GEORGIA—II. THE COASTAL PLAIN[1]

RUTH O. SCHORNHERST

Only three papers dealing exclusively with the mosses of Georgia have been published, none treating the Coastal Plain section of the state. Many scattered references to Georgia collections are found in Grout's *Moss Flora*, and in papers by McVaugh, Anderson, *et al.* These, added to data from my own collections, those of J. K. Small, and herbarium material from the New York Botanical Garden and the University of Michigan, have served as the source of material for the present paper and the one to follow. The result is a surprisingly lengthy list of species, although several which might be expected to occur are not included, owing mainly to the haphazard nature of most of the collecting. Before publishing this list I had expected to do more personal collecting and to make further study of important southern collections such as that at Duke University, but travel restrictions due to the war have prevented. Although I realize the limitations of the present list, I feel that it is large enough and representative enough to present as a preliminary report.

Georgia lies within two of the major physiographic regions of the United States, the Atlantic Plain on the southeast and the Appalachian Region on the northwest. The latter includes parts of four provinces: the Central Upland, the Appalachian Mountains, the Appalachian Valley and Ranges, and the Appalachian Plateau (fig. 1). The present paper deals exclusively with the Coastal Plain; the other regions, with the exception of the Appalachian Plateau, which has been covered by the recent paper by Carroll (1945), will be treated later.

The Coastal Plain, bordering the coast of the United States from southern New England to and into Mexico, occupies all of Georgia south of a crooked line connecting Augusta, Milledgeville, Macon, and Columbus (fig. 1). This crooked line is the Fall Line, a transition zone some five to ten miles wide, marking the coast line of an earlier geologic era. It is easily observable in the streams, where rapids and falls develop (hence the name), but is often difficult to discern on the ridges between since there are no appreciable soil differences between the two regions. The Piedmont, just north of the Fall Line, is underlain by ancient granites and other crystalline rocks, while to the south of it underlying the surface soils are softer

[1] The first paper of this series appeared as: Mosses of Stone Mountain, Georgia. Bryologist 48: 29–33. 1945.

sedimentary rocks such as limestone, or in some places clay or sand. Approximately three-fifths of the total area of the state, 35,650 square miles,

FIG. 1. Map of Georgia, showing the provinces. 1. Coastal Plain. 2. Central Upland. 3. Appalachian Plateau. 4. Appalachian Valley and Ranges. 5. Appalachian Mountains.

is included in the Coastal Plain. The topography is partly rolling, partly flat. The underlying formations are mantled by a wide variety of soils, including red clay, gray limestone soils, and light-colored sands. Some of

these soils represent greatly decomposed formations like the Alum Bluff, others are Pleistocene in origin. Streams rising within the Coastal Plain are clear, owing to the leaching by sandy banks and beds, but those rivers rising to the north and flowing across it are for the most part turbid and discolored by dissolved organic matter. Lakes, sometimes numerous, may be original depressions or may be formed by solution of limestone. Some of these limesink lakes are quite large and deep. Along the Savannah River occur lakes which are nothing more than abandoned river channels. Swamps are abundant in the southern parts of the Coastal Plain, where the ground is frequently low. Best known of these swamps is the Okefenokee Swamp, an original depression covering 660 square miles, second in size in the United States only to the Dismal Swamp of Virginia. At least five coastal terraces, derived from sea bottom and converted into land by the withdrawal of the sea to a lower level, are recognized (LaForge, Cooke, *et al.*).

The southern states are conspicuous for the exceedingly heavy growth of bryophytes and other small plants which thrive where moisture is abundant and where growing conditions foster long periods of vegetative growth. The southern half of Georgia has a warm, moist climate, with long summers having frequent and heavy rainfall, and with short mild winters. The growing season (from last spring frost to first fall frost) averages 250 days near the Georgia-Florida border, and rainfall ranges from 50 to 55 inches per year. These figures are representative of the general climatic situation in most of the Georgia Coastal Plain.

The states bordering the Gulf of Mexico are of considerable significance to one interested in the distribution of plants. The majority of species of mosses found here, it is true, are typical of much of eastern North America, but the area is a critical one for studying the mingling of temperate and tropical or subtropical species. Interest in any area not previously studied intensively centers around the unusual or unexpected species found there. For example, to list such ubiquitous species as *Bryum argenteum* or *Polytrichum commune* would not cause much excitement in the bryological world, but when characteristically tropical species such as *Syrrhopodon ligulatus, Fissidens subcrenatus,* or *Mittenothamnium diminutivum* are found in the same region as *Haplohymenium triste* or *Platygyrium repens,* characteristic of more northern localities, then one realizes that the region needs close scrutiny.

Anderson (1938) listed 38 species of mosses commonly found in the Coastal Plain of North Carolina. Of these, 18 are known from the Georgia Coastal Plain, and at least eight others probably occur more or less frequently, for they do in northern Florida, which is much like southern Georgia in topography, climate, and vegetation-types. Figure 2 shows the distribution of *Bruchia Donnellii,* a species confined to the Coastal Plain,

while figures 3 and 4 show the distribution of *Tetraplodon pensylvanicus* and *Cryphaea glomerata* which, although not restricted to the Coastal Plain, have their greatest concentration there. Other characteristic species are *Syrrhopodon texanus, Homalotheciella fabrofolia, Sphagnum macrophyllum, Sphagnum henryense, Sphagnum portoricense, Entodon Drummondii, Pogonatum brachyphyllum,* and *Ptychomitrium Drummondii.* Such species as *Clasmatodon parvulus, Plagiothecium micans, Schlotheimia Sullivantii,* and *Schwetschkeopsis denticulata* are found throughout the southern

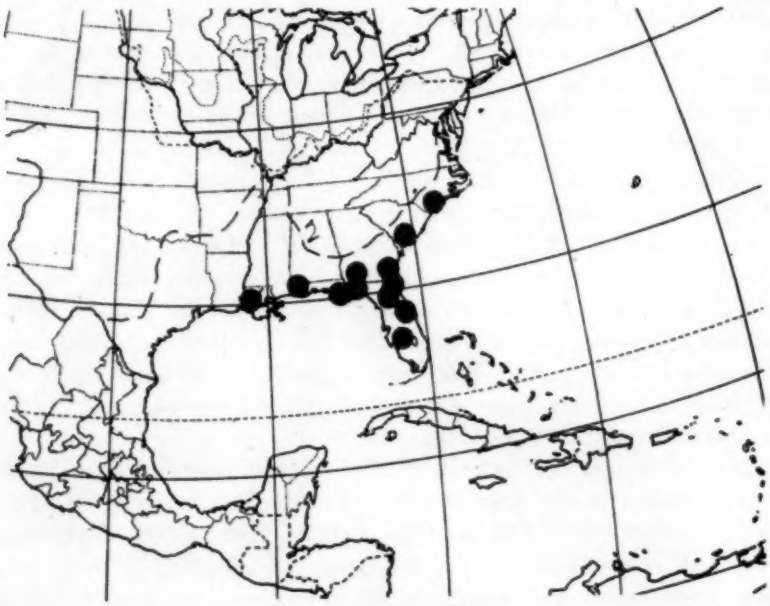


FIG. 2. Distribution of *Bruchia Donnellii.*

states, while *Cirriphyllum Boscii, Thelia hirtella, Entodon seductrix, Sciaromium Lescurii, Climacium Kindbergii,* and *Leucodon julaceus* are widely distributed throughout eastern North America. Some species, such as *Plagiothecium micans, Leucodon julaceus, Forsstroemia trichomitria,* and *Weisia viridula* probably grow in every county in the state. *Fontinalis Sullivanti* has been considered a Coastal Plain species, but it seems more characteristic of the entire eastern part of the country, being known from Florida, Georgia, Louisiana, Alabama, Missouri, Arkansas, Tennessee, Delaware, New Jersey, Pennsylvania, New York, Connecticut, Massachusetts, Maine, and Nova Scotia (Welch, in litt.).

In recent years a number of writers have shown that present distribution of plants can be better interpreted if we know something of their past

distribution. One collection of fossils in South Georgia and one in northern Florida give the only clue so far to the fossil fauna and flora of the Georgia Coastal Plain, but that clue is significant. The Miocene of Florida and Georgia consists of three formations, the Chattahoochee, the Chipola, and the Chesapeake, in order of age (Foerste). During the early Miocene the

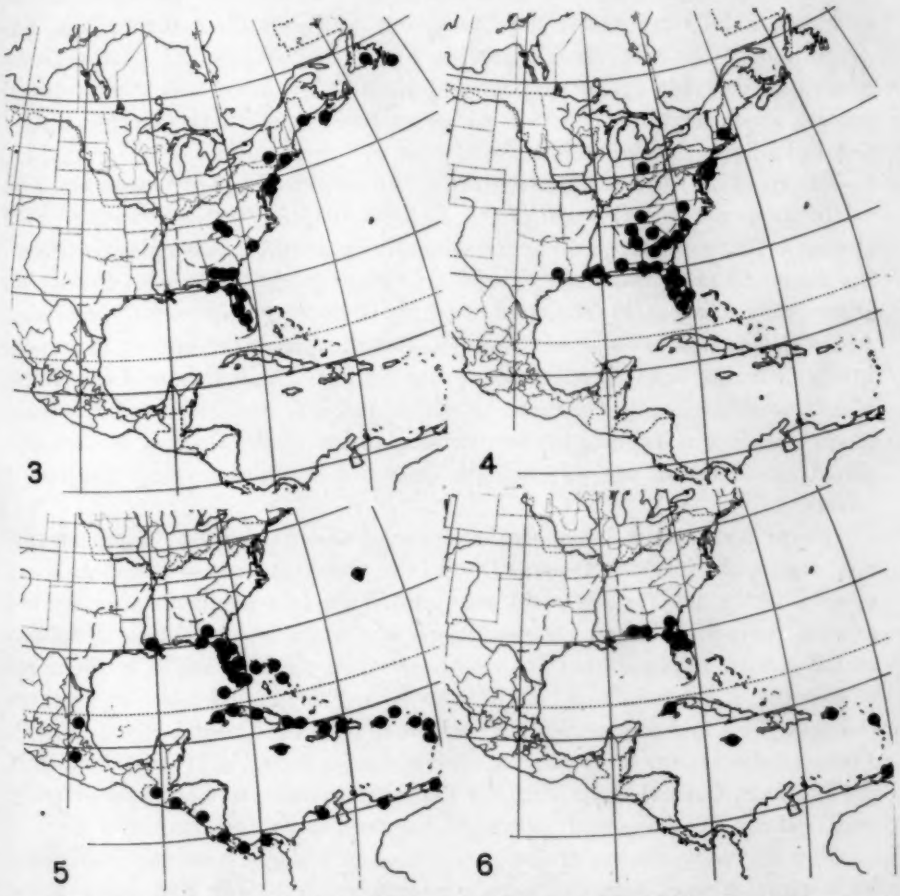


FIG. 3. Distribution of *Tetraplodon australis*. FIG. 4. Distribution of *Cryphaea glomerata*. FIG. 5. Distribution of *Mittenothamnium diminutivum*. FIG. 6. Distribution of *Syrrhopodon ligulatus*.

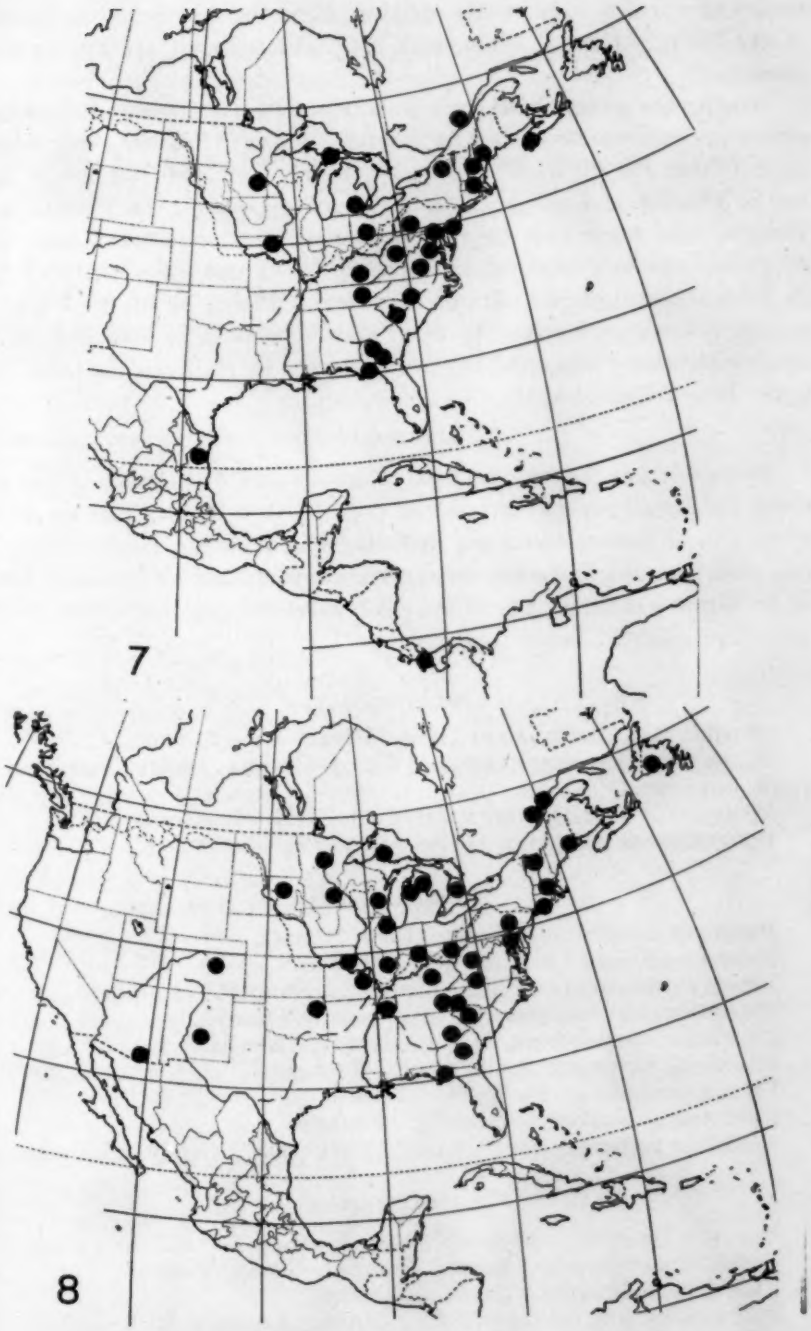
Okefenokee Current, a return-current from the Gulf of Mexico, went through the Okefenokee Straits. The Chipola fauna, of decidedly subtropical (Antillean or Caribbean) facies, extended all along this passage and some distance northward. Collections made between Bainbridge and Fowlstown, in Decatur County, show this clearly. Later the Chesapeake, a cold south-

west-running current, introduced northern forms of marine life all along the southern border of the Miocene continent. The Alum Bluff formation in northern Florida, forty miles southwest of the Georgia deposits, indicates much the same condition, namely, a tropical flora receiving replacements and additions from a more temperate one (Berry). The present situation in peninsular Florida, and to a very limited extent in southern Georgia, is that of an essentially temperate flora receiving additions from the tropics. Examination of the spot maps (showing known collections) of *Mittenothamnium diminutivum* or *Syrrhopodon ligulatus* (figs. 5, 6) will show tropical species which have reached their northern limit in southern Georgia, only a few miles from the Bainbridge fossil area.

Sharp (1944) has called attention to the large number of mosses common to the areas north and south of the Mexican–United States boundary (142 species). Of these thirty occur occasionally in southern Georgia. Outstanding examples are *Campylopus fragilis, Campylopus gracilicaulis, Dicranella Herminieri, Dicranella Hilariana, Barbula Crügeri, Fissidens polypodioides,* and *Rhizogonium spiniforme*. Seventy of these species are known from peninsular Florida, many from almost every county. The hot, humid conditions which seem necessary for most of these tropical and subtropical mosses change rapidly as soon as the moderating effects of the Gulf of Mexico and the Atlantic Ocean are left behind. Only a few miles produce noticeable effects.

There is not much conclusive evidence of the extension of northern species southward into the Coastal Plain; the transition is too gradual. Many species which are for the most part restricted to more northerly regions extend southward wherever conditions are suitable. Although *Haplohymenium triste* occurs rather frequently in other southern states to the north of Georgia, it has been reported only twice in Florida and twice in southern Georgia. This makes it appear to be moving into the Coastal Plain (fig. 7). *Platygyrium repens* is another northern species found only occasionally in the southern Coastal Plain (fig. 8). This situation is probably true of many small plants. Too frequently oversight has been taken for absence.

Few intensive studies of the distribution of a single species of moss have been made. If such material were available, many of our spot maps would show more continuous distribution from one section of the country to another. One of the best studies of this sort is that of Anderson on *Tortula pagorum* (1943), a species which, although spotty in occurrence, usually grows abundantly wherever it is found. Scarcity of elms in southern Georgia and Florida may account for its absence in those regions, although Anderson has found it growing on live oaks, pecans, and other ridged-barked trees in addition to its usual elm habitat. It reaches its maximum development in the Piedmont, but is sufficiently common in the Coastal Plain, where it



Explanation of figures 7 and 8

FIG. 7. Distribution of *Haplohymenium triste*. FIG. 8. Distribution of *Platygyrium repens*.

occurs erratically, to be rather striking. It has been collected in 12 counties in the Georgia Coastal Plain, and 154 stations in all are known for this species.

Among the mosses with limited distribution not already discussed three others are interesting enough to receive comment. *Fissidens subcrenatus* is known from Puerto Rico (as *F. pellucidus*), from two stations in Mexico, one in Florida, and one in Georgia (Lowndes County). In 1930 Roland M. Harper, who made this Georgia collection, also collected a new species, *Rhynchostegiella georgiana*, in a swamp about two miles south of Macon, in Bibb County, at the edge of the Coastal Plain; so far as I know this species is not known from any other station. *Solmsiella biseriata* (as *Erpodium biseriatum*) was collected near Augusta by Sullivant in 1845, but has never been collected again.

LIST OF SPECIES

Nomenclature follows the lists of mosses and *Sphagnum* in the special check-list number of *The Bryologist* (vol. 43, Oct. 1940). Since no check list of species of mosses occurring in Georgia is available, county records are included. In a few instances this procedure could not be followed, for some of Dr. Grout's collections from the Okefenokee Swamp bore no location data. These are marked simply "Okefenokee."

POLYTRICHACEAE

Catherinaea Macmillani Holz. Glynn, Grady, Thomas.
Pogonatum brachyphyllum (Rich.) Beauv. Dodge, Lowndes, Randolph, Richmond, Thomas.
Pogonatum pensilvanicum (Hedw.) Paris. Randolph.
Polytrichum commune Hedw. Lowndes, Okefenokee.

FISSIDENTACEAE

Fissidens adiantoides Hedw. Clay, Sumter.
Fissidens Bushii Card. & Thér. Thomas.
Fissidens minutulus Sull. Richmond, Stewart.
Fissidens osmundioides Hedw. Decatur, Grady.
Fissidens polypodioides Hedw. Grady, Thomas.
Fissidens Ravenelii Sull. Grady, Thomas.
Fissidens subbasilaris Hedw. Thomas.
Fissidens subcrenatus Schimp. Lowndes.
Fissidens viridulus (Web. & Mohr) Wahlenb. Grady, Richmond.

DITRICHACEAE

Bruchia Donnellii Aust. Thomas, Ware.
Ditrichum pallidum (Hedw.) Hampe. Grady, Thomas.
Pleuridium Ravenelii Aust. Richmond.
Pleuridium subulatum (Hedw.) Lindb. Lowndes, Richmond.

DICRANACEAE

Campylopus fragilis (Dicks.) Bry. Eur. Okefenokee, Ware.
Campylopus gracilicaulis Mitt. Ware.
Dicranella Herminieri Besch. Randolph, Thomas.
Dicranella heteromalla (Hedw.) Schimp. Glynn.
Dicranella Hilariana (Mont.) Mitt. Loundes, Randolph, Thomas.
Dicranella varia (Hedw.) Schimp. Loundes.
Dicranum condensatum Hedw. Camden, Richmond.

LEUCOBRYACEAE

Leucobryum albidum (Brid.) Lindb. Brooks, Chatham, Glynn, Loundes, Randolph, Richmond, Stewart, Walton, Ware.
Leucobryum glaucum (Hedw.) Schimp. Ware.

CALYMPERACEAE

Syrrhopodon floridanus Sull. Okefenokee.
Syrrhopodon ligulatus Mont. Clinch.
Syrrhopodon texanus Sull. Loundes, Okefenokee.

POTTIACEAE

Barbula Crügeri Sond. Grady, Dougherty.
Tortella humilis (Hedw.) Jennings. Bibb.
Tortula pagorum (Milde) DeNot. Appling, Bibb, Chatham, Emanuel, Jefferson, Liberty, Macon, Richmond, Sumter, Toombs.
Weisia viridula Hedw. Grady, Thomas.

GRIMMIACEAE

Ptychomitrium Drummondii Sull. Chatham, Richmond, Thomas.
Ptychomitrium incurvum (Muhlenb.) Sull. Richmond, Tatnall.

EPHEMERACEAE

Ephemerum megalosporum (Aust.) Salm. Bibb.
Ephemerum serratum (Hedw.) Hampe. Sumter.

FUNARIACEAE

Funaria flavicans Mx. Glynn, Richmond.
Funaria hygrometrica Hedw. var. patula Bry. Eur. Ware.
Funaria serrata Brid. Bibb, Chatham.
Physcomitrium turbinatum (Mx.) Brid. Chatham, Richmond, Ware.

SPLACHNACEAE

Tetraplodon pensylvanicus (Brid.) Grout. Clinch, Colquit, Ware.

ERPODIACEAE

Solmsiella biseriata (Aust.) Steere. Richmond.

ORTHOTRICHACEAE

Schlotheimia Sullivantii C. Müll. Brooks, Charlton, Effingham, Grady, Thomas.

BARTRAMIACEAE

PHILONOTIS LONGISETA (Rich.) E. G. Britton. Thomas.
PHILONOTIS GLAUCESCENS (Hornsch.) Paris. Grady, Thomas.

BRYACEAE

BRYUM ARGENTEUM (L.) Hedw. Daugherty, Grady.
BRYUM CAPILLARE (L.) Hedw. Okefenokee.

MINACEAE

MNIUM AFFINE Bland. Thomas.

RHIZOGONIACEAE

RHIZOGONIUM SPINIFORME (Hedw.) Bruch. Grady.

HYPNACEAE

AMBLYSTEGIUM VARIUM (Hedw.) Lindb. Dougherty.
BRACHYTHECIUM SALEBROSUM (Web. & Mohr) Bry. Eur. Thomas.
CAMPYLIUM CHRYSOPHYLLUM (Brid.) Bryhn. Grady, Richmond.
CHAMBERLAINIA ACUMINATA (Hedw.) Grout. Chattahoochee.
CLIMACIUM KINDBERGII (Ren. & Card.) Grout. Wayne.
ENTODON DRUMMONDII (Bry. Eur.) Jaeger & Sauerb. Thomas.
ENTODON SEDUCTRIX (Hedw.) C. Müll. Dougherty, Glynn, Grady, Thomas, Wayne.
EURHYNCHIUM HIANS (Hedw.) Jaeger & Sauerb. Dougherty.
EURHYNCHIUM RAPPII (Williams) Grout. Grady.
EURHYNCHIUM SERRULATUM (Hedw.) Kindb. Loundes, Thomas.
HOMALOTHECIELLA FABROFOLIA (Grout) Broth. Berrien, Thomas.
HOMALOTHECIELLA SUBCAPILLATA (Hedw.) Card. Sumter.
HYPNUM CUPRESSIFORME Hedw. Thomas.
HYPNUM PATIENTIAE Lindb. Thomas, Wayne.
HYPNUM PRATENSE Koch. Wayne.
LEPTODICTYUM RIPARIUM (Hedw.) Warnst. Grady.
MITTENOTHAMNIUM DIMINUTIVUM (Hampe) E. G. Britton. Grady.
PLAGIOTHECIUM GEOPHILUM (Aust.) Grout. Decatur.
PLAGIOTHECIUM MICANS (Sw.) Paris. Berrien, Charlton, Coffee, Grady, Loundes, Randolph, Sumter, Thomas, Ware, Wayne.
RHYNCHOSTEGIELLA GEORGIANA Dix. & Grout. Bibb.
SCIAROMIUM LESCURII (Sull.) Broth. Grady.
SEMATOPHYLLUM ADNATUM (Mx.) E. G. Britton. Charlton, Coffee, Grady, Loundes, Montgomery, Sumter, Tatnall, Thomas, Okefenokee.

LESKEACEAE

ANOMODON ATTENUATUS (Hedw.) Hüben. Dougherty, Thomas.
ANOMODON MINOR (Beauv.) Lindb. Dougherty.
HAPLOHYMENIUM TRISTE (Cesati) Kindb. Dougherty, Grady.
LESKEA AUSTRALIS Sharp. Dougherty.
THELIA ASPRELLA Sull. Coffee, Tatnall, Taylor.
THELIA HIRTELLA (Hedw.) Sull. Dougherty, Grady, Loundes, Thomas, Wayne.

THUIDIUM DELICATULUM (Hedw.) Mitt. Grady, Thomas.
THUIDIUM MICROPHYLLUM (Hedw.) Best. Grady.

LEUCODONTACEAE

FORSSTROEMIA TRICHOMITRIA (Hedw.) Lindb. Grady, Thomas.
FORSSTROEMIA TRICHOMITRIA (Hedw.) Lindb. var. IMMERSA (Sull.) Lindb Grady, Okefenokee.

CHRYPHAEACEAE

CRYPHAEA GLOMERATA Schimp. Richmond, Sumter.

FABRONIACEAE

CLASMATODON PARVULUS (Hampe) Sull. Charlton, Grady, Thomas.
FABRONIA RAVENELII Sull. Richmond, Thomas.
SCHWETSCHKEOPSIS DENTICULATA (Sull.) Broth. Thomas, Okefenokee.

FONTINALACEAE

BRACHELYMA ROBUSTUM (Card.) E. G. Britton. Colquitt, Jefferson, Laurens, Miller.
BRACHELYMA SUBULATUM (Beauv.) Schimp. Chatham, Wayne.
FONTINALIS DISTICHA Hook. & Wils. Wayne.
FONTINALIS SULLIVANTI Lindb. Grady.
FONTINALIS DALICARLICA Bry. Eur. Dougherty.

SPHAGNACEAE

SPHAGNUM CUSPIDATUM Ehrh. var. SERRULATUM Schlieph. Charlton, Clinch, Dodge.
SPHAGNUM CYCLOPHYLLUM Sull. & Lesq. Sumter.
SPHAGNUM HENRYENSE Warnst. Charlton.
SPHAGNUM MACROPHYLLUM Bernh. Charlton, Sumter.
SPHAGNUM MAGELLANICUM Brid. Charlton, Ware.
SPHAGNUM PALUSTRE L. Chatham, Coffee, Decatur, Richmond, Screven, Sumter, Tift.
SPHAGNUM PORTORICENSE Hampe. Charlton.
SPHAGNUM RECURVUM Beauv. Brooks, Coffee, Laurens, Randolph, Richmond, Ware.
SPHAGNUM STRICTUM Sull. Charlton, Dodge, Ware.
SPHAGNUM SUBSECUNDUM Nees. Brooks.

FLORIDA STATE COLLEGE FOR WOMEN
TALLAHASSEE, FLORIDA

Literature Cited

Anderson, L. E. 1938. The mosses of North Carolina II. Bryologist **41**: 1–11.

————. 1943. Distribution of *Tortula pagorum* (Milde) DeNot. in North America. Bryologist **46**: 47–66.

Andrews, A. LeRoy. 1940. List of the North American species of *Sphagnum*. Bryologist **43**: 132.

Berry, E. W. 1916. Physical conditions and age indicated by the flora of the Alum Bluff formations. Prof. Paper U. S. Geological Survey **98**: 41–59.

Blomquist, H. L. 1937. Mosses of North Carolina. I. Sphagnales. Bryologist **40**: 67–71.

Carroll, Gladys. 1945. The bryophytes of the Appalachian Plateau in northern Georgia. Bryologist **48**: 11–24.

Foerste, A. F. 1893. Studies of the Chipola Miocene of Bainbridge, Georgia. Am. Jour. Sci. III. **36**: 244–254.

Grout, A. J. 1940. List of mosses of North America north of Mexico. Bryologist **43**: 117–131.

————. 1941. Bryology in the Okefenokee. Bryologist **44**: 120–122.

LaForge, Laurence, Wythe Cooke, et al. 1925. Physical geography of Georgia. Geol. Survey of Georgia Bull. **42**. 189 pp.

McVaugh, Rogers. 1943. The vegetation of the granitic flat rocks of the southeastern United States. Ecol. Monogr. **13**(2): 120–166.

Schornherst, Ruth. 1940. A preliminary list of mosses from northern Florida. Bryologist **43**: 57–73.

————. 1941. A second list of mosses from northern Florida. Bryologist **44**: 117–119.

Sharp, A. J. 1944. Some problems in American bryology. Lilloa **10**: 265–283.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 167–183 MARCH, 1946

THE EFFECT OF COLCHICINE AND ACENAPHTHENE IN COMBINATION WITH X-RAYS ON PLANT TISSUE—III[1]

MICHAEL LEVINE

ACENAPHTHENE

In another study made on the root-tips of the "Yellow Globe" variety of *A. cepa* the effects induced by exposures to acenaphthene were examined. This substance has been reported by Kostoff (1938a, b, c) and others as having an effect on nuclear divisions similar to if not greater than that of colchicine. It seemed of interest to study the effect of this chemical on growth and to determine its value in combination with x-rays. Several experiments with this agent were made concurrently with the colchicine studies. In one experiment 12 bulbs were germinated for 8 days and then placed in a saturated solution of acenaphthene for 48–50 hours. The root-tips were irradiated with 900r and then returned to water. Non-x-rayed acenaphthene-treated bulbs and a few chemically untreated ones were kept as controls. The treated bulbs were studied microscopically after their return to water for 13 days. A study of the acenaphthene-treated bulbs showed that the swellings induced by this chemical after an exposure of 48 hours were slight, and in most of these experiments the roots failed to retain the hypertrophies after the bulbs were returned to water for three or four days. Sections of these root-tips were studied and brief reference will be made to these preparations below. In both the acenaphthene-treated controls and the acenaphthene-x-rayed bulbs many of the roots became water-soaked and flaccid, although it appeared that new roots had been formed (fig. 6). Outgrowths of the 48-hour-acenaphthene-x-rayed roots were small and became completely arrested (bulbs 21, 29, 30) five days after their return to water, while the bulbs treated with acenaphthene alone (bulb 9) showed marked growth, although the swellings on the long roots were barely distinguishable. Compared with those obtained with colchicine at the concentrations used here, the reactions were much slower and weaker.

In another experiment fifteen onions were germinated in water for seven days, after which six were placed into 0.01 per cent solution of colchicine, six in a saturated solution of acenaphthene, and three were chemically untreated. After 48 hours of exposure to the substances, the roots of three bulbs from each group, with two of the untreated bulbs, were irradiated with 3000r. All the bulbs in the series were then returned to water. Samples from each group

[1] Previous parts of this study appeared in Bull. Torrey Club **72**: 563–574; **73**: 34–59.

were photographed after their return to water (fig. 37). Bulb 3 was colchicinized and irradiated, bulb 6 was colchicinized only, and bulb 13 was irradiated only. Bulb 11 was immersed in acenaphthene and irradiated, bulb 9 was treated with acenaphthene only, while bulb 15 was untreated. The irradiation was administered, as already described, for 30 minutes at 100r per minute.

A comparison of the colchicine-treated and acenaphthene-treated bulbs six days after their return to water (bulbs 6, 9) showed strikingly the difference in effect produced by these substances under similar conditions. The terminal outgrowths from the diminutive hypertrophies on the acenaphthene-treated roots were longer than those on the colchicinized bulbs; secondary roots were formed from both.

The growth-retarding effects were more pronounced after colchicine-irradiation treatment than after acenaphthene-irradiation. Considerable elongation of the root-tips occurred after the latter treatments (compare bulb 3 with 11) when the bulbs were returned to water for 6 days. The roots on the irradiated control bulbs (bulb 13) elongated slightly and some secondary roots were formed. The water controls grew actively and formed numerous secondary roots (bulb 15). It appears obvious that acenaphthene is not so active as colchicine as a "tumor"-producing agent. The hypertrophies are small, but the division stages appear to be as numerous in both types of chemical treatment for a given exposure. The acenaphthene activity seems to be limited by the insolubility of the compound. Levan (1940) reached a similar conclusion. The need for covering the roots with the crystals before any gross visible action is induced detracts from the usefulness of this agent in these studies.

Microscopic studies made of this series of root-tips confirmed the observations reported above. In root-tips taken from bulbs irradiated with 3000r after acenaphthene and returned to water for 13 days (fig. 38) the meristem was reduced in volume. It was represented only by a small collection of embryonic cells. A comparatively thick layer of collapsed cells covered the remaining terminal portion of the root. The terminal cells were empty. The plerome tissue was well differentiated and contained a number of viable cells in division stages. Normal spiral vessels were found in this tissue. The cortical cells appeared normal and well differentiated. Root-tips from the irradiated colchicinized bulbs showed more intense destruction than in the irradiated controls. The cells were more mature and larger, nuclei were densely stained although some appeared well differentiated. The number of viable cells appeared to be smaller (fig. 39). More empty, highly vacuolate cells were found in the cortical parts of the root. The number of cells in the remainder of the meristem was small. Spiral vessels were not common but present. Cytologically, the acenaphthene-treated and irradiated (3000r) root-tips appeared much like the root-tips irradiated only.

In another experiment the effects of colchicine and 1500r were contrasted with those of acenaphthene and 1500r. The root-tips of 15 onions of the "Yellow Globe" variety were used. Six bulbs were exposed to colchicine, and six to a saturated solution of acenaphthene for 48 hours and three were chemically untreated. Seven of these bulbs (3 colchicine, 3 acenaphthene, 1 untreated) were irradiated with 1500r. After the irradiation, all bulbs were returned to water. The colchicinized bulbs recovered; new outgrowths appeared from the bulbous tips together with many secondary roots. The root-tips of the colchicinized and irradiated plants made no outgrowths or little protuberances from the hypertrophied tips; no secondary roots were formed (fig. 40). The root-tips treated with acenaphthene for 48 hours and irradiated (1500r) resumed growth after having been returned to water for six days (fig. 40, bulb 25). This growth was not strikingly less than that of the acenaphthene-treated bulbs without irradiation (fig. 40, bulb 23). The hypertrophies were small and in both series were barely perceptible after their removal from water. It seems that the injury here was considerably less than with the colchicinized-irradiated root-tips. The acenaphthene-treated and irradiated root-tips resembled more closely the root-tips which were irradiated only (fig. 40, bulb 28). A comparison between the colchicinized-irradiated and acenaphthene-treated and irradiated root-tips showed unquestionably that the former treatment delayed and impaired growth more actively than the latter. The roots of the non-irradiated non-chemically treated plants (fig. 40, bulb 29) appeared longer than the others, they had been growing in water for 16 days.

Microscopical examinations of these chemical-treated root-tips were made immediately before and after irradiation and after their return to water. The observations on these colchicine-treated bulbs were similar to those described above. The colchicinized-irradiated roots, examined 11 days after their return to water showed some destruction of their peripheral tissues, yet a center of viable meristematic cells was always present. In contrast with this stage the irradiated but chemically untreated root-tips were normal in structure four days after their treatment. Some cells were in division stages and no visible impairment of structure or function was seen (fig. 41). When roots from these bulbs were examined microscopically 11 days after their return to water, they had few dividing cells. Many peripheral cells were empty and the walls were deeply stained. The nuclei appeared to be contracted, although clearly differentiated.

A number of fixations were made from the root-tips of acenaphthene-treated bulbs (fig. 40, bulb 23). Metaphases were abundant and resembled those induced by colchicine (fig. 42). The cells, however, were little hypertrophied, which was in accord with the macroscopic findings. Four days after their return to water, the acenaphthenized-irradiated bulbs showed few, if

any, aberrant changes (fig. 43). The nuclei were in resting stages. Irregularly reconstructed or lobulate nuclei were not found. The effects observed in these preparations were less strikingly aberrant than those observed in colchicinized and 1500r treated roots after their return to water for the same period.

Combined colchicine and x-rays were more injurious than either acenaphthene and x-rays or x-rays alone. The effects produced by acenaphthene and x-rays combined were little different from those changes induced by x-rays alone. From these experiments it appears that the colchicine at the concentration and with the length of exposure used has some toxic effects; which, when followed by irradiation, produce permanent changes and lead to complete growth inhibition and possibly hasten destruction. Acenaphthene induces mitotic stasis and seems to contribute little to the effect induced by x-rays.

THE EFFECT OF LONG PERIODS OF GERMINATION

It was pointed out that the onions used in the colchicine-x-ray studies described above were germinated in water from 3 to 12 days. At this time the roots had attained an average length of 3–4 cm. In the majority of experiments, the bulbs were kept in water for eight days before they were transferred to the colchicine solution. It was important to determine whether this period of germination influenced recovery from colchicine treatment. It was necessary to determine the effect of prolonged growth in water on the production of the colchicine tumors and on recovery. The effect of prolonged treatment with 0.01 per cent solution of colchicine on root-recovery was studied. The outgrowth from the hypertrophied root-tips which appeared in 24–96 hours after colchicine exposure was used as one of the criteria of recovery and viability. Forty onions of the "Yellow Globe" variety were selected at random. Their weights varied from 70 to 140 g. These bulbs were set in black-coated glass cylinders filled with tap water on Sept. 26, 1941. These bulbs were examined daily, and the cylinders were rinsed daily in hot water and refilled with cool tap water.

Bulbs 1–16 were kept in water for eight days (table 1) and then transferred to other cylinders filled with 0.01 per cent aqueous solution of colchicine. Bulbs 17–32 were grouped in pairs and kept in water for 12 days. Beginning at this time a pair of bulbs was transferred to the colchicine solution on each succeeding day until the exposure to colchicine varied from 1 to 14 days. After a given colchicine exposure, the bulbs were washed and returned to fresh water. Bulbs 33–40 inclusive were grown in water uninterruptedly during the time. The number of roots produced by each bulb was not counted but variations were observed. All the colchicine-treated bulbs produced hypertrophied root-tips. These bulbous tips varied in size in proportion to the cross section of the root-tip. The roots which were grown in water for 15–19

days before colchicine was applied formed long attenuated roots; their colchicinized root-tips were small, thin spindle-shaped swellings. When the colchicinized bulbs, 1–16, were returned to water, the resumption of growth from the bulbous tip occurred in all but two. These were bulbs 10 and 11 which were in colchicine eight and nine days respectively. In the entire series,

TABLE 1. *Viability of roots of Allium cepa var. Yellow Globe as affected by duration in water and length of exposure to 0.01% aqueous soln. of colchicine, recovery tested by return to water.*

Bulb number	In water, days	In colchicine, days	Growth of tip resumed in water after colchicine, days
1	8	4	±16
2	8	4	± 8
3	8	5	± 6
4	8	5	± 6
5	8	6	±10
6	8	6	± 6
7	8	7	± 6
8	8	7	± 6
9	8	8	± 4
10	8	8	−16
11	8	9	−16
12	8	9	± 4
13	8	10	±10
14	8	10	± 7
15	8	11	± 9
16	8	11	± 8
17	12	12	± 9
18	12	12	±10
19	13	12	± 8
20	13	12	± 6
21	14	12	± 7
22	14	12	± 7
23	15	13	−13
24	15	13	± 4
25	16	14	± 2
26	16	14	± 2
27	17	3	± 8
28	17	3	± 8
29	18	2	−14
30	18	2	−14
31	19	1	± 2
32	19	1	−14

− No resumption of growth.
± Outgrowth from bulbous tip.

six bulbs failed to show recovery; bulb 23 which was in water for 15 days and in colchicine for 13 days showed no outgrowth from the bulbous tip 13 days after it had been returned to water. Of the six bulbs 27–32, retained in water for 17–19 days followed by a short exposure of colchicine, three failed to resume growth. These roots appeared to be viable. While their growth activity was not measured it was apparently little. Secondary roots had already formed on these plants before they were placed in the colchicine.

When plants 1–16 were discarded on Oct. 28, only bulb 12 had produced 6 leaves. The bulbs at that time were all firm and free from any visible mycotic disease. Most of the bulbs had new roots while bulb 10 was poor in that respect; its longest roots were 7 cm. and no secondary roots had been formed. Bulb 11 produced a moderate number of roots which attained a length of 15 cm. Bulbs 17 and 18 were discarded on Nov. 2. No leaves had been produced by then; the length of the greater number of their roots measured 15 cm. The remaining bulbs were discarded when they had remained 14 days in water after the colchicine exposure. The bulbs were firm and had a moderate number of roots, some of which had produced a number of secondaries. No leaves were formed. On Nov. 6, 1941, the control bulbs were firm and had no leaves. They all had long white roots with an abundance of secondary ones. The length of the greater number varied from 15 to 35 cm. The capacity of these bulbs to form roots was tested by removing all the roots and replacing them in water. A new crop of roots was formed and maintained their growth to Dec. 12, 1941, when the experiment was discontinued.

THE EFFECT OF LONG PERIODS OF COLCHICINE

In another experiment 24 bulbs of the same variety were kept in water from 8 to 28 days. Beginning with the 9th day, two bulbs were exposed to colchicine; on the 12th day two more bulbs were transferred to colchicine, and on successive alternate days the same treatment was given to two more bulbs (table 2). Those bulbs that were kept in water for a short period were given long exposures to colchicine. Long exposures to water were accompanied by short treatments in colchicine. The results showed clearly that the roots exposed to 0.01 per cent colchicine from 15 to 20 days failed to resume growth. The hypertrophied root-tips remained macroscopically unchanged. The roots, however, were not dead, for secondary roots appeared on all bulbs, from two to three days after their return to water. In the tests in which the bulbs were kept in water for 20–28 days and exposed to colchicine 2–12 days, the growth of the hypertrophied tips began in from one to three days. Bulbs 23 and 24 had long attenuated roots with small hypertrophies. The bulbous tips had apparently very little growth-power and showed only slight elongations of the tips two weeks after they had been returned to water. Secondary roots, when immersed in colchicine, formed hypertrophies too, proportionate to their diameters.

It is evident that the solution of colchicine used in the above experiments and the period of germination used before microscopical studies were made, had no effect on the viability or the growth-capacity of the roots. It is evident, too, that while colchicine inhibited growth, some toxic invisible effects were produced in addition to those which interfered with spindle formation and regular chromosome division. Exposure to colchicine for more than 12

days inhibited growth of the root. The ability to form secondary roots was not disturbed.

A study of these bulbs was made to determine the effects of 0.01 per cent aqueous solution of colchicine on the number of the roots produced during treatment and after their return to water. The number of roots was counted at four periods (table 3); at the end of eight days of germination, immediately before exposure to colchicine, immediately after exposure, and finally

TABLE 2. *Viability of roots in Allium cepa var. Yellow Globe as affected by duration in water and length of exposure to 0.01% aqueous soln. of colchicine, recovery tested by return to water.*

Bulb number	In water, days	In colchicine, days	Growth of tip resumed in water after colchicine, days	Secondary roots formed in water after colchicine, days
2	8	20	−14	SR+3
3	8	20	−14	SR+3
4	12	18	−14	SR+2
5	12	18	−14	SR+2
7	14	17	−14	SR+2
8	14	17	−14	SR+2
10	SR 16	15	−14	.....
11	SR 16	15	−14	.....
12	SR 16	15	−14	.....
13	SR 18	14	+ 4	.....
14	SR 18	14	−14	.....
15	SR 20	12	−14	.....
16	SR 20	12	± 3	.....
17	22	10	± 3	SR+2
18	22	10	± 3	SR+2
19	SR 24	6	± 1	.....
20	SR 24	6	± 4	.....
21	SR 26	4	± 3	.....
22	SR 26	4	± 4	.....
23	SR 28	2	±14	.....
24	SR 28	2	±14	.....

+ Elongation of bulbous root tip.
± Outgrowth from bulbous tip.
− No recovery.

14 days after return to water. The weights of the bulbs were determined before the experiment began, but the number of roots formed after the eight-day period showed that this factor influenced root-production little. Bulbs 11, 12, and 13, for instance, weighed 70 g. before exposure to water and produced 30, 65, and 70 roots respectively after eight days. Bulb 24 weighed 90 g. and produced 40 roots in the same period. Marked variations were recorded at the period before the bulbs were immersed in colchicine. Bulb 22 produced 44 roots during the first eight days, while after 26 days, before the colchicine was used, it had 101 roots. In nearly half the bulbs an increase was shown in the number of roots after the colchicine exposure. The increase in root numbers was beyond the range of error. In 13 bulbs, there

was no change or a slight decrease in the number of roots. On bulbs 8, 15, 16, and 21 there was a considerable decrease in the number of roots. This may be attributed to the death of the root followed by complete disintegra-

TABLE 3. *The effect of 0.01% aqueous soln. of colchicine on the number of roots of Allium cepa var. Yellow Globe.*
N—new T—turgid F—flaccid Fx—fixed

Bulb number	Number of roots							
	In water		In colchicine	14 days in water after colchicine	Analysis			
					N	T	F	Fx
days	8		20					
1	39		66	59	2	45	6	6
2	37		43	41	8	20	12	1
3	26		52	63	4	55	2	2
days	8	12	18					
4	40	40	40	48	13	22	9	4
5	43	43	58	46	5	37	4	0
days	8	14	17					
7	39	44	58	57	2	40	13	2
8	25	43	33	50	15	32	3	1
days	8	16	16					
10	30	40	46	52	0	29	21	2
11	30	37	37	37	3	31	2	1
12	65	93	93	93	0	60	26	6
days		18	14					
13		70	68	76	2	65	8	1
14		67	95	79	4	67	8	1
days		20	12					
15		56	38	38	6	17	15	0
16		38	31	28	0	22	6	0
days	8	22	10					
17	40	47	49	61	17	38	6	0
18	28	48	52	43	9	29	3	2
days	8	24	6					
19	22	54	56	66	15	48	2	1
20	66	95	97	90	3	70	12	5
days	8	26	4					
21	55	58	51	59	12	26	15	6
22	44	101	102	96	0	74	19	3
days	8	28	2					
23	48	62	62	64	7	46	8	3
24	40	78	78	66	18	37	9	2

tion due to other factors and not to colchicine only. The count made 14 days after the bulbs were returned to water showed some variation; eight bulbs showed an increase in the number of roots formed. An actual number of

viable roots would include the new roots, the turgid long roots, and those fixed for microscopic examination. The number of flaccid, water-soaked roots varied from 2 to 26 roots per bulb. The number of new roots formed varied from 2 to 18. It was clear that the long exposure of the roots to water with

TABLE 4. *Viability of roots of Allium cepa as affected by duration of exposure to 0.01% aqueous soln. of colchicine followed by x-rays and return to water.*
Bulbs were grown in water for 8 days before treatments began.

Bulb number	In colchicine, hours	Secondary root formation, days	Growth from bulbous tip in water after colchicine, days
Group A 1500r var. Yellow Globe			
25	18	23	+ 25
26	18	....	+ 21
27	18	18	+ 21
28	18	....	+ 21
29	18	....	+ 21
no xr 30	18	8	± 21
no xr 31	18	10	± 24
Group B 1500r var. Yellow Globe			
33	36	....	+ 25
34	36	....	–
35	36	....	+ 21
36	36	....	+ 21
37	36	....	+ 21
no xr 38	36	20	± 21
no xr 39	36	20	± 21
Group A 1500r var. Brigham Yellow Globe			
1	48	....	E –
2	48	....	–
3	48	....	E –
4	48	....	–
6	48	....	–
no xr 18	48	4	± 3
Group B 3000r var. Brigham Yellow Globe			
7	48	....	–
8	48	....	–
9	48	....	–
11	48	....	–
12	48	....	–
no xr 14	48	4	± 3

+ Slight extension of root from bulbous tip.
± Continued outgrowth of root from bulbous tip.
– No outgrowth from bulbous root-tip, 30 days.
E Extension and elongation of root tips.

short exposure to colchicine had no more effect on the number of roots produced than long exposures in colchicine coupled with short exposures to water. The number of roots produced by a bulb is probably a genetic factor.

Colchicine, in the concentration used, inhibits growth, and water restores this growth ability.

VIABILITY OF ROOTS AFTER COLCHICINE AND X-RAYS

The roots of the "Yellow Globe" and the "Brigham Yellow Globe" varieties were also studied as to their ability to recover from the colchicine and x-ray treatments. The bulbs were germinated for eight days and then

TABLE 5. *The number and length of roots of Allium cepa var. Yellow Globe before and after exposure to 0.01% aqueous soln. of colchicine and x-rays. The bulbs were placed in water on 11.3.41. Group A was exposed to colchicine on 11.11.41 for 18 hours; irradiated on 11.12.41 and returned to water. Group B was exposed to colchicine on 11.11.41 for 36 hours; irradiated on 11.13.41 and returned to water.*

c^1—colchicine—18 hours c^2—colchicine—36 hours x—irradiation 1500r 11 min.
T—turgid F—flaccid Fx—fixed

Bulb number treatment	Number of roots					Maximum length of roots		
	8 days in water, cm.	8 days after colchicine and irradiation, cm.	27 days after colchicine and irradiation, cm. T	F	Fx	After colchicine, before iradiation, cm.	22 days after colchicine and irradiation, cm.	30 days after colchicine and irradiation, cm.
Group A								
6x	35	42	33	9	7	14.5	12	13.5
32x	44	36	48	10	13	11	11	11
25c^1x	37	53	64	3	3	11	12	16
26c^1x	26	27	36	4	2	11.5	10	9
27c^1x	35	67	44	4	8	15.5	16	16
28c^1x	47	55	60	2	12	12	13	15
29c^1x	33	33	39	4	4	14.5	13	14
30c^1	36	49	37	8	5	13.5	18	19.5
31c^1	34	46	89	2	5	11	19	20
Group B		7 days	26 days				21 days	29 days
9x	35	27	33	7	18	13	15	15
40x	66	81	67	6	14	19	20	18
33c^2x	72	71	80	9	7	12.5	12	13
34c^2x	25	18	15	4	5	15.5	16	16
35c^2x	23	25	29	4	2	13	13	13
36c^2x	57	59	44	3	7	13	12	13.5
37c^2x	79	69	58	11	12	9	10	11
38c^2	75	104	98	17	6	13	15	20
39c^2	33	36	49	4	3	11	23	28

exposed for 18, 36, or 48 hours to colchicine, which was followed by an exposure of 1500r or 3000r (see table 4). The "Yellow Globe" exposed for 18 and 36 hours showed some limited growth of bulbous root-tips, while the non-x-rayed bulbs showed more extensive growth after their return to water. The "Brigham Yellow Globe" exposed to colchicine for 48 hours showed some slight extensions or elongation of the bulbous tips after an exposure to x-irradiation of 1500r but no growth or elongation was noted after 3000r exposure. These observations were made 30 days after their return to water.

A study was made of the number and maximum length of roots in the "Yellow Globe" and "Brigham Yellow Globe" varieties. These results are tabulated in tables 5 and 6. On bulbs 6x and 32x (table 5, Group A) irradiated only with 1500r the longest roots did not increase in length, but the number of roots increased. The colchicine and irradiated group, $25c^1x$–$29c^1x$, recovered temporarily; the new outgrowths were small, most of them measuring 0.5 cm. or less. The bulbs $30c^1$ and $31c^1$ treated with colchicine showed greater increase in length and number of roots. The inhibiting influence of the combined effects of colchicine and x-rays was not entirely overcome even after 30 days in water.

TABLE 6. *The number and length of roots of Allium cepa var. Brigham Yellow Globe before and after exposure to 0.01% aqueous soln. of colchicine and x-rays. The bulbs were placed in water on 12.19.41; exposed to colchicine on 12.27.41; irradiated on 12.29.41 and returned to water.*

c—colchicine—48 hours x^1—irradiation 1500r—15 min. x^2—irradiation 3000r—30 min.
T—turgid F—flaccid Fx—fixed

Bulb number, treatment	Number of roots				Maximum length of roots				
	8 days in water	21 days after treatment T	F	Fx	8 days in water	2 days after colchicine, before irradiation, cm.	4 days after irradiation, cm.	12 days after irradiation, cm.	19 days after irradiation, cm.
$1cx^1$	43	39	0	3	11	11	12	10	10
$2cx^1$	55	37	15	7	10	11	11	11.5	11.5
$3cx^1$	62	40	4	7	9	10.5	10.5	9.5	10
$4cx^1$	59	52	10	10	13	14	14	13.5	14
$6cx^1$	24	14	8	2	13.5	15	14	12.5	11.5
$5x^1$	23	36	0	8	11	13.5	16	15	12
$16x^1$	23	33	7	7	10	13.5	13	12	13
$7cx^2$	61	25	30	3	13	12.5	14	13	14
$8cx^2$	31	29	14	3	14	14	15	11	11
$9cx^2$	66	34	9	20	13	14	13	12	12
$11cx^2$	62	32	14	7	10	11	11	11	11
$12cx^2$	59	.....	.....	.....	10	10	.....	.....	.....
$13x^2$	44	14	18	7	10	13	10	10	10
$17x^2$	24	29	6	7	13	15	10	11	10
14c	40	46	8	8	12	14	15	18	18
18c	46	60	0	7	14	14	14.5	17	17
10	11	.....	.....	.....	12	12	10.5	12	.....
15	16	24	5	0	11.5	14	18	16	19

In Group B, $33c^2x$–$37c^2x$, in which the colchicine treatment lasted 36 hours and was followed by x-irradiation with 1500r, the number of roots increased slightly while the length of the largest roots increased little. On bulbs 9x and 40x, 26 days after their return to water, the number and length of roots increased. The bulbs treated with colchicine only ($38c^2$ and $39c^2$), however, showed the largest increase in number and length of roots.

Colchicine treatments which lasted 48 hours and were followed by irradiation of 1500r and 3000r were also studied and recorded in table 6. There

was a slight diminution in the number of roots after the treatment with colchicine and with the higher dosage of x-rays. There appeared also to be a large number of flaccid roots in this group. Bulbs irradiated only, $5x^1$ and $16x^1$, gained in number of roots, while $13x^2$ showed a slight decrease in the total number of roots present and bulb $17x^2$ showed a gain. The colchicinized bulbs 14c, 18c, gained in root number and root length. The roots of bulbs treated with colchicine and x-rays combined measured slightly less in length than the roots of the bulbs irradiated only. The latter gained slightly in the 19-day period over the 12-day period, while with the large dosage of x-rays used, no increased growth was evident. This colchicine-x-ray group lost length. In the above studies the loss in average length of root was due to the fact that the long roots, apparently the older ones, which were used as a basis for comparison, were the first to die. It seemed that the length and number of roots of bulbs treated with colchicine for 48 hours followed by irradiation with 3000r were impaired more by this treatment than by the x-rays alone.

SUMMARY AND CONCLUSIONS

1. The above report deals with the combined effect of a 0.01 per cent aqueous solution of colchicine and x-irradiation on the root-tips of *Allium cepa,* varieties "Yellow Globe" "Brigham Yellow Globe."

2. Fifteen series of experiments were made, each using from 6 to 40 bulbs.

3. The gross effects of this solution of colchicine on the root-tips of these bulbs were studied and compared with microscopic examinations after periods of exposure varying from 6 to 200 hours.

4. The root-tips of onion bulbs were studied in the gross and microscopically especially after 18, 24, 36, 48, 72, and 120 hours of exposure to colchicine of a constant concentration followed by exposures to one of three doses of x-rays, 900r, 1500r, and 3000r. The combined effect was studied shortly after irradiation and at various periods after the return of the bulbs to water. Untreated colchicinized bulbs, and bulbs x-rayed only, were used as controls and studied concurrently in each series of experiments.

5. The effect of colchicine exposures for more than 48 hours followed by irradiation of 900r prevented growth of the root-tip; 48-hour exposure to colchicine with 1500r induced similar results. Exposures of 48 hours combined with 3000r prevented further growth of the root-tip. With the shorter exposures to colchicine, 18, 24, 36 hours, and 1500r, the hypertrophied tips produced only a limited growth which became arrested from five to seven days after their return to water.

6. Irradiation with 900r, 1500r or 3000r impaired growth; the time for recovery was less than that required for the combined effect of colchicine and x-rays.

7. A study of length and number of roots of the bulbs treated with colchicine for 18, 36, 48 hours followed by irradiations of 1500r or 3000r was made. The viability of the roots was tested by returning them to water. Root-tips treated with colchicine alone resumed growth in from 72 to 96 hours. Those irradiated only resumed growth more slowly. The colchicine-x-rayed roots failed to resume growth.

8. Exposure of the roots to the colchicine solution for 28 days appeared only slightly toxic. The hypertrophies of the root-tip when returned to water still showed evidence of recovery by new growth from the small bulbous tips. Roots grown in water for long periods and exposed for from 24 to 48 hours in colchicine reacted with hypertrophies proportional to the area of the cross section of the root-tip.

9. Cytological studies of the root-tips were made of normal untreated roots from 3 to 12 days after exposure to water; from 6 to 200 hours after exposure to colchicine; and after various periods which began immediately before their return to water and continued to 14 days after the colchicine and x-ray exposures were made. Root-tips irradiated only were fixed before and after the treatment. The fixations began from one to two hours after irradiation and at daily intervals thereafter up to 14 days. The cytological observations on these root-tips after colchicine combined with x-rays were consistent with the measurements made on root number and root lengths. These root-tips showed slower recovery as evidenced by fewer divisions found in these roots as compared with those x-rayed only.

10. The cytological phenomena which immediately resulted from the colchicine-x-ray treatments were more intensified clumping, fragmentation, and extrusion of chromosomes. There appeared to be some visible effects on the resting nuclei in that the chromatic material was distributed near the nuclear membrane leaving a clear area about the nucleoli. Twenty-four hours after irradiation, no division stages were found. Three or four days after the treatment, the cells irradiated only began to divide, while those that received the colchicine and x-rays combined showed few nuclear divisions. The nuclei became homogeneously stained; the meristem was interspersed with many highly vacuolated cells.

11. These cytological studies do not favor the view that the greatest number of cellular injuries occurred when irradiations were made at the time when the metaphase stages were most abundant. The colchicine appeared to sensitize the cells to x-rays at the time when nuclear reconstruction began, which occurred about 48 hours after the exposure to colchicine was started.

12. Onion roots covered with crystals of acenaphthene and exposed to a saturated solution of this chemical produced only small hypertrophies after 48 hours and little or no gross visible changes after shorter exposures. The effects on nuclear and cell divisions, however, appeared similar to those pro-

duced by colchicine. The combination of acenaphthene and x-rays in which 900r, 1500r, and 3000r were used followed closely the results obtained with x-rays alone.

13. "Colchicine tumors" are not analogous to animal neoplasia or plant overgrowths induced by bacteria or growth substances.

14. The combination of an exposure of 900r and a treatment with 0.01 per cent aqueous solution of colchicine for less than 72 hours, or 1500r and 48 hours of colchicine, are most effective in arresting growth of fundamental plant tissues such as the root-tip of the onion.

15. It is suggested that more intensive studies be made with this drug combined with x-rays on tumors of animals and man. The fact that some animal tumors and simple but normal plant structures show delayed growth after such treatment makes it necessary to obtain suitable concentration of colchicine followed by a selective dose of x-rays which will tend to inhibit and to destroy cancerous tissue without interfering with normal life processes of the host.

LABORATORY DIVISION, MONTEFIORE HOSPITAL
NEW YORK

Literature Cited

Bates, G. H. 1939. Colchicine-induced polyploidy in nature. Nature **143**: 643.

Brown, N. A. 1939. Colchicine in the prevention, inhibition, and death of plant tumors. Phytopathology **29**: 221–231. *2 f.*

————. 1942. The effect of certain chemicals, some of which produce chromosome doubling, on plant tumors. Phytopathology **32**: 25–45. *2 f.*

Brues, A. M. & Jackson, E. B. 1937. Nuclear abnormalities resulting from inhibition of mitosis by colchicine and other substances. Am. Jour. Cancer **30**: 504–511. *11 f.*

Brues, A. M., Marble, B. B. & Jackson, E. B. 1940. Effects of colchicine and radiation on growth of normal tissues and tumors. Am. Jour. Cancer **38**: 159–168. *1 f.*

Dermen, H. 1940. Colchicine, polyploidy, and technique. Bot. Rev. **6**: 599–635.

Dermen, H. & Brown, N. A. 1940a. Cytological basis of killing plant tumors by colchicine. Jour. Hered. **31**: 197–199. *2 f.*

———— & ————. 1940b. A cytological study of the effect of colchicine on plant tumors. Am. Jour. Cancer **38**: 169–190. *10 f.*

Dixon, W. E. & Malden, W. 1908. Colchicine with special reference to its mode of action and its effect on bone-marrow. Jour. Physiol. **37**: 50–76. *15 f.*

Duhamet, L. 1939. Action de la colchicine sur la croissance de méristèmes radiculaires de *Lupinus albus*. Compt. Rend. Soc. Biol. **131**: 757–759. *1 f.*

Dustin, A. P. 1934. Contribution à l'étude de l'action des poisons caryoclasiques sur les tumeurs animales. II. Action de la colchicine sur le sarcome greffé, type Crocker, de la souris. Bull. Acad. Roy. Méd. Belg. **14**: 487–502.

————. 1937. La colchicine et ses applications à l'analyse de quelques problèmes de cytophysiologie. Mél. Jean Demoor. 170–180. *4 f.*

————. 1938. L'action des arsénicaux et de la colchicine sur la mitose. La stathmocinèse. Compt. Rend. Assoc. Anat. **33**: 204–212.

Dustin, A. P. & Grégoire, C. 1933a. Contribution à l'étude de l'action des poisons caryoclasiques sur les tumeurs animales. I. Action du cacodylate de Na et de la trypa-

flavine, sur le sarcome greffé, type Crocker, de la souris. Bull. Acad. Roy. Méd. Belg. 13: 585–592.

———— & ————. 1933b. Action caryocinétique des composés arsénicaux sur les tumeurs greffées. Compt. Rend. Soc. Biol. Paris 114: 195, 196.

Eigsti, O. J. 1938. A cytological study of colchicine effects in the induction of polyploidy in plants. Proc. Nat. Acad. 24: 56–63. *36 f.*

————. 1940a. Effects of colchicine upon the nuclear and cytoplasmic phases of cell division in the pollen tube. Genetics 25: 116, 117.

————. 1940b. The effects of colchicine upon the division of the generative cell in *Polygonatum, Tradescantia,* and *Lilium.* Am. Jour. Bot. 27: 512–524. *66 f.*

Fatalizade, F. A. 1939. Acenaphthene-induced polyploidy in *Nicotiana.* Compt. Rend. Acad. Sci. U. R. S. S. 22: 180–183.

Favorski, M. V. 1939. New polyploidy-inducing chemicals. Compt. Rend. Acad. Sci. U. R. S. S. 25: 71–74.

Garrigues, R. 1939. Action de la colchicine et du chloral sur les racines de *Vicia faba.* Compt. Rend. Acad. Sci. Paris 208: 461–463.

Gavaudan, P. 1938. Sur les tissus à constitution mixte diploïde et polyploïde développés chez les végétaux par action de la colchicine. Compt. Rend. Soc. Biol. 128: 717–719. *1 f.*

————. 1941. Action du 1,2,3,4,5 tétraméthylbenzène sur la carcinogénèse, la cytodierèse et la croissance végétales. Compt. Rend. Trav. Fac. Sci. Marseille 1: 40–42.

Gavaudan, P. & Gavaudan, N. 1937. Modifications numériques et morphologiques des chromosomes, induites chez végétaux par l'action de la colchicine. Compt. Rend. Soc. Biol. 126: 985–988. *7 f.*

———— & ————. 1938. Mécanisme d'action de la colchicine sur la caryocinèse des végétaux. Compt. Rend. Soc. Biol. 128: 714–716.

———— & ————. 1939a. Comparaison du mode d'action de quelques substances inhibitrices de la caryocinèse. Compt. Rend. Soc. Biol. 130: 432–434.

———— & ———— 1939b. Action de l'apiol sur la caryocinèse et la cytodierèse chez quelques phanérogames. Compt. Rend. Acad. Sci. Paris 209: 805–807.

Gavaudan, P., Gavaudan, N. & Durand, J. 1938. Sur la similitude d'action de l'acénaphtène et de la colchicine dans l'inhibition de la caryocinèse. Compt. Rend. Soc. Biol. 129: 559–562. *1 f.*

———— & ————. 1939. Action du naphtalène et du diphényle sur la caryocinèse. Compt. Rend. Soc. Biol. 130: 53–56.

Gavaudan, P., Gavaudan, N. & Pomriaskinsky-Kobozieff, N. 1937. Sur l'influence de la colchicine sur la caryocinèse dans les méristèmes radiculaires de l'*Allium cepa.* Compt. Rend. Soc. Biol. 125: 705–708.

Guyer, M. F. & Claus, P. E. 1939. Irradiation of cancer following injection of colchicine. Proc. Soc. Exp. Biol. Med. 42: 565–568. *1 f.*

Györffy, B. 1940a. Chromosome numbers of polyploids obtained by colchicine treatment. Magyar Biol. Kutatóintézet Munkái 12: 326–329. [Chem. Abstr. 35: 1089. 1941.]

————. 1940b. The mechanism of colchicine action. Magyar Biol. Kutatóintézet Munkái 12: 330–351. [Chem. Abstr. 35: 1089. 1941.]

Havas, L. 1937a. Effects of colchicine and of *Viscum album* preparations upon germination of seeds and growth of seedlings. Nature 139: 371.

————. 1937b. L'action de la colchicine sur le développement du "phytocarcinome" de la tomate. Bull. Assoc. Franç. Etude Cancer 26: 635–662. *5 f.*

————. 1938. Is colchicine a "phytohormone"? Growth 2: 257–260.

————. 1939. Colchicine and colchicine effects. Chem. Prod. 1–5.

————————. 1940. Sur quelques problèmes de croissance étudiés à l'aide de la colchicine, chez les plantes et chez les animaux. Soc. Roy. Sci. Méd. Natur. 3–30.

Hirschfeld, J. W., Tennant, R. & Oughterson, A. W. 1940. The effect of colchicine and x-ray on a transplantable mammary carcinoma in mice. Yale Jour. Biol. Med. **13**: 51–60. *8 f.*

Hukusima, E. 1939. Acenaphthene as a polyploidizing agent. Proc. Imp. Acad. Tokyo **15**: 98–100. [Chem. Abstr. **33**: 6391, 6392. 1939.]

Kostoff, D. 1938a. Irregular mitosis and meiosis induced by acenaphthene. Nature **141**: 1144, 1145.

————————. 1938b. Colchicine and acenaphthene as polyploidizing agents. Nature **142**: 753.

————————. 1938c. Induction of somatic chromosome duplication and production of polyploid chromosomal chimeras due to acenaphthene and colchicine. Arch. Exp. Zellforsch. **22**: 203.

————————. 1938d. Irregularities in the mitosis and polyploidy induced by colchicine and acenaphthene. Comp. Rend. (Koklady) Acad. Sci. U. R. S. S. **19**: 197–199. *4 f.*

————————. 1939. Induction of polyploidy by pulp and disintegrating tissue from *Colchicum* sp. Nature **143**: 287, 288. *f. a, b.*

Levan, A. 1938. The effect of colchicine on root mitoses in *Allium*. Hereditas **24**: 471–486. *7 f.*

————————. 1939. Cytological phenomena connected with the root swelling caused by growth substances. Hereditas **25**: 87–96. *3 f.*

————————. 1940. The effect of acenaphthene and colchicine on mitosis of *Allium* and *Colchicum*. Hereditas **26**: 262–276. *5 f.*

Levine, M. 1931. Studies in the cytology of cancer. Am. Jour. Cancer **15**: 144–211. *45 f.*; 788–834. *55 f.*; 1411–1494. *65 f.*

————————. 1945a. Colchicine and X-rays in the treatment of plant and animal overgrowths. Bot. Rev. **11**: 145–180.

————————. 1945b. The effect of colchicine and X-rays on onion root tips. Cancer Research **5**: 107–119. *6 f.*

Levine, M. & Gelber, S. 1943. The metaphase stage in colchicinized onion root-tips. Bull. Torrey Club **70**: 175–181. *1 f.*

Levine, M. & Lein, J. 1941. The effect of various growth substances on the number and the length of roots of *Allium cepa*. Am. Jour. Bot. **28**: 163–168.

Lits, F. J. 1936. Recherches sur les réactions et lésions cellulaires provoquées par la colchicine. Arch. Internat. Méd. Exp. **11**: 811–901. *12 f.*

Lits, F. J., Kirschbaum, A. & Strong, L. C. 1938a. Action of colchicine on a transplanted malignant lymphoid neoplasm in mice of the C3H strain. Am. Jour. Cancer **34**: 196–213. *32 f.*

————————, ————————— & ————————. 1938b. Action of colchicine on a malignant lymphoid neoplasm in mice of an inbred strain. Proc. Soc. Exp. Biol. Med. **38**: 555–557.

Love, W. H. 1931. Some effects of x-radiation on dividing cells in tissue cultures. Arch. Exp. Zellforsch. **11**: 435–471.

Ludford, R. J. 1936. The action of toxic substances upon the division of normal and malignant cells *in vitro* and *in vivo*. Arch. Exp. Zellforsch. Mikr. Anat. A. **18**: 411–441. *4 pl. 5 f.*

Mangenot, G. 1938a. Effets de la colchicine sur la mitose dans les racines d'*Allium cepa* et d'*Hyacinthus orientalis*. Compt. Rend. Soc. Biol. **128**: 501–504.

————————. 1938b. Hypertrophies des racines produites par la colchicine chez quelques plantes. Compt. Rend. Soc. Biol. **128**: 565–568.

————. 1939. L'action de la colchicine sur les cellules végétales. Compt. Rend. Acad. Sci. Paris **208**: 222–224.

Marquardt, H. 1938. Die Röntgenpathologie der Mitose I und II. Zeits. Bot. **32**: 401–482.

Marshak, A. & Hudson, J. C. 1937. Measurement of Roentgen-ray dosage by determining the effect of radiation on chromosomes. Radiology **29**: 669–675. *3 f.*

Mol, W. E. de. 1939. Proeven met acenaphteen. I, II. Herba Topiaria **3**(8): 11–16.

Nebel, B. R. 1937. Mechanism of polyploidy through colchicine. Nature **140**: 1101.

————. 1938. Colchicine and acenaphthene as polyploidizing agents. Nature **142**: 257.

Nebel, B. R. & Ruttle, M. L. 1938. The cytological and genetical significance of colchicine. Jour. Hered. **29**: 3–9. *frontisp., 4 f.*

Nichols, C. 1941. Spontaneous chromosome aberrations in *Allium*. Genetics **26**: 89–100. *1 pl.*

Sax, K. 1941. The behavior of X-ray induced chromosomal aberrations in *Allium* root tip cells. Genetics **26**: 418–425.

Schmuk, A. A. 1938. The chemical nature of substances inducing polyploidy in plants. Compt. Rend. Acad. Sci. U. R. S. S. **19**: 189–192.

Schmuk, A. A. & Gusseva, A. 1939. Structure of substances inducing polyploidy in plants. Comp. Rend. Acad. Sci. U. R. S. S. **24**: 441–446.

Seed, L., Slaughter, D. P. & Limarzi, L. R. 1940. Effect of colchicine on human carcinoma. Surgery **7**: 696–709. *10 f.*

Shimamura, Tamaki. 1938. Experiments of the treatment of tomatoes with colchicine solution. Jap. Jour. Genet. **14**: 304–308. *5 f.* [Biol. Abstr. **15**: 868(10025). 1941.]

————. 1939a. Cytological studies of polyploidy induced by colchicine. Cytologia [Tokyo] **9**: 486–494. *18 f.*

————. 1939b. Effects of the action of acenaphthene and colchicine upon the pollen mother-cells of *Fritillaria verticillata* Willd. var. *thumbergii* Baker. Jap. Jour. Genet. **15**: 179–180 *2 f.* [Biol. Abstr. **15**: 868(10026). 1941.]

Simonet, M. 1940. [Colchicine-type anomalies of plant caryokinesis produced by 1,3,5-trinitro-m-xylene.] Compt. Rend. Soc. Biol. **133**: 561–563. [Chem. Abstr. **34**: 6324. 1940.]

Simonet, M. & Guinochet, M. 1939a. Sur l'appariton dans les tissus végétaux de cellules polyploïdes sous l'influence des vapeurs de paradichlorobenzène. Compt. Rend. Soc. Biol. **130**: 1057–1060. *1 f.*

————. 1939b. [Effects obtained with α-chloronaphthalene and α-bromonaphthalene comparable to those exerted by colchicine on the caryokinesis of plants.] Compt. Rend. Acad. Sci. **208**: 1427, 1428. [Chem. Abst. **33**: 5886. 1939.]

Simonet, M. & Igolen, G. 1940. Obtention, sous l'influence d'essence de petit grain mandarinier, d'effets comparables à ceux exercés par la colchicine sur les caryocinèses végétales. Compt. Rend. Acad. Sci. Paris **210**: 510, 511.

Solacolú, Th., Constantinesco, M. & Constantinesco, D. 1939. Action de la colchicine sur les tumeurs végétales provoquées par le *Bacillus tumefaciens*. Compt. Rend. Soc. Biol. **130**: 1148–1150.

Villars, R. 1940. Effect of X-irradiation on colchicine-treated roots. Compt. Rend. Soc. Biol. **133**: 424–426. [Brit. Chem. Phys. Abst. 942. 1941.]

Weichsel, G. 1940. Polyploidie, veranlasst durch chemische Mittel. Insbesondere Colchicinwirkung bei Leguminosen. Züchter **12**: 25–32.

Wellensiek, S. J. 1939. The newest fad, colchicine, and its origin. Chron. Bot. **5**: 15–17.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 184–193 MARCH, 1946

REMARKS UPON CERTAIN HAWAIIAN LABIATAE AND COMPOSITAE

EARL EDWARD SHERFF

In a recent issue of this magazine (**72**: 25–30. 1945), there appeared from St. John's pen a contribution touching in great part upon certain Labiatae and Compositae that had been treated previously by me. Various assertions, these sometimes direct and sometimes by implication or innuendo, were made touching my monographic studies of Hawaiian plants. For thirty years (but more intensively for the past fifteen) I have taken an active interest in these monographic studies and have produced from time to time papers detailing their results. It now appears advisable, therefore, to set forth for future users of these results a somewhat detailed reply to Dr. St. John's paper. This indeed seems imperative in view especially of such words as: "the now numerous, hurried revisions of Hawaiian genera by Sherff. These treatments and keys have proven to be the despair of students of the Hawaiian flora." That these revisions are now numerous must perhaps be admitted, but is due in large part to the almost unparalleled cooperation of botanists and botanical institutions in Europe, the United States, and the Hawaiian Islands. The important specimens by Hillebrand, Gaudichaud, Nuttall, Beechey, Chamisso, Rock, Faurie, Forbes, Degener, and practically all other collectors of Hawaiian plants were placed at my disposal, often for as much as from three to six years.[1] To say that St. John is warranted in terming these revisions "hurried," however, would seem to imply considerable intimacy on his part with the conditions under which the work was carried on. This is the more surprising when we consider that much of the time since 1929, when he first took up residence in the Hawaiian Islands, he has been removed several thousand miles from Chicago, the seat of my botanical activity. It seems preferable to believe, rather, that he has found himself vexed by the inadequacy of some of these revisions (surely some cannot be otherwise until our herbaria become more richly supplied with specimens) and accordingly used the first word that came to mind. It may be insisted before going further, however, that the revisions were never "hurried." Fortunately, all of my Hawaiian researches have been privately conducted on my own time, with no compulsion or inducement from any outside source whatever to do

[1] As illustrative of this cooperation, more than twenty-five years ago Charles N. Forbes and his associates at the Bishop Museum in Honolulu assembled and sent to me a vast collection of Hawaiian *Bidens* material, in which ten new species were found (cf. Field Mus. Bot. Ser. **16**: 11. 1937).

a "hurried" piece of work. Consequently, any matters observed or assumed by St. John to merit criticism in the finished product should be otherwise explained. Certain such matters will now be noticed.

LABIATAE

Under the new combination *Stenogyne mollis* (Sherff) St. John, is given (p. 25) a discussion of the predecessor name *S. rugosa* var. *mollis* Sherff. Reasons are stated for elevating the variety to specific rank. Reasons for not doing so are omitted. To properly understand any of the latter that may exist, it should be remembered that the Hawaiian Islands are geographically much isolated and in turn abound in individual, often very small localities of great isolation. There is remarkable endemism. Many of the species studied by competent monographers have been found to have numerous varieties. Ofttimes these varieties, if viewed separately, will appear to be distinct species and indeed may differ mutually more than do some generally recognized species elsewhere. When all are assembled side by side, however, they are seen to form a very logical species-complex ("Formkreis"). It actually happens that in some cases important supravening, connecting links seem to have vanished in recent years from the Hawaiian flora; at least they have not been found for many decades and are known today only through herbarium specimens (*Euphorbia Remyi* A. Gray ex Boiss., the species proper, and *E. multiformis* H. & A., the species proper, being examples). One becomes sorely tempted to relegate such links to the realm of paleobotany, and proceed with a fresh delimitation of species. He can seldom be sure, however, but what one or more of the lost (or shall we say missing) links will yet be found to have escaped destruction and to have reappeared to press its claims. In my own revisions of Hawaiian plants, I have chosen always to base specific and varietal concepts, therefore, upon the fullest assortment of specimens to be had, regardless of whether or not they represented entities known to be still living.

To return to *Stenogyne rugosa:* After making virtually a monographic study of *Stenogyne* many years ago, Asa Gray (Proc. Am. Acad. **5**: 348. 1862) wrote of this species: "Variat, 1. fere omnino (corolla excepta) glaberrima, laevis, seu pedicellis calycibusque hirsutulis: 2. hirsutula vel hispidula, foliis nunc rugosis asperulis: 3. pube brevi molli induta, verticillastris 6–10-floris." It is the third form that was the basis of my var. *mollis*. The second form was referred by me (op. cit. 66) to *S. rugosa* proper. It was because of this somewhat intermediate[2] form's existence that I preferred to treat the third form not as a distinct species, but rather as a variety of *S. rugosa,* namely var. *mollis*.[3]

[2] Intermediate as to pubescence.

[3] Certain characters (of uniformity of pubescence, of calyx-lobe length and shape,

Under *Stenogyne rugosa* Benth., St. John places as synonyms *S. rugosa* var. *subulata* Sherff and *S. kaalae* var. *coriacea* Degener & Sherff, following these with a discussion. My own discussion now follows. In 1872, Wawra described *S. kaalae* (Flora **55**: 556), although Thomas Nuttall had long before collected it on Oahu and given it the unpublished name, *Phaeopsis montana* (a specimen in Herb. Kew; cf. Benth. in DC. Prodr. **12**: 556. 1848, nom. nud.). Hillebrand accepted Wawra's species, and rightly so. Among other characters noted for it was the very exceptional one that the pedicels, when several at a node, were "often joined in a short common peduncle." Until the recent description by Degener of *Stenogyne Sherffii* (Brittonia **5**: 58, *fig. 1.* 1943), *S. kaalae* was the only species of *Stenogyne* known with this character. In the sister genus *Phyllostegia* previously monographed by me (Bull. Bish. Mus. **136**: 12–59. 1935), only the one species *P. glabra,* together with its varieties, was known with a like character (although recently a second such species has been described, namely *P. Yamaguchii* Hos. & Deg., Occas. Papers Bish. Mus. **14**: 27–29, *fig. 1.* 1938). Somewhat prior to 1935, two suites of *Stenogyne* specimens, *Degener 5371* and *5389,* were studied and found to display the axillary peduncles previously known in *Stenogyne* only for *S. kaalae.* These were then named *S. kaalae* var. *coriacea* Degener & Sherff. In my monograph I cited a lone herbarium for each suite since the rest of the specimens had not yet been distributed by Degener to other herbaria. In the place of official publication (Deg. Fl. Haw. Isls. Sept. 13, 1935), however, it was stated that duplicates were "in the Degener Herbarium, in that of the New York Botanical Garden, and in several other leading herbaria in America and Europe."[4] Hence it can be seen that there was more than pure caprice of fancy to dictate our treatment of the two Degener suites as a variety of *S. kaalae.*

In making his interpretation of var. *coriacea,* St. John apparently overlooks not only the importance of the *frequently pedunculate inflorescence* character but also the fact, clearly indicated long ago by Hillebrand and later by myself, that the number of flowers per whorl is not constant. Thus Hillebrand wrote: "Verticillasters or whorls *generally* [italics mine] 2-flowered" versus "whorls *generally* [italics mine] 6-, but also 4-, 8-, or 10-

etc.) stressed by St. John for his *Stenogyne mollis* fail badly on extended examination of specimens.

It is interesting to note that as recently as 1943, Skottsberg, writing on Dr. Sven Berggren's collection of Hawaiian Vascular Plants (Bot. Notis. **1943**: 368), retained my *mollis* as a variety and described under it a new forma *mollissima.* Moreover, a plant collected by himself (his no. 621) and previously cited by me for the var. *mollis,* was described by him (doubtless from a *duplicate* of the specimen actually studied by me) as "more like ordinary rugosa" in the "texture of leaf and size of corolla."

[4] Unfortunately the artist who delineated the sketch for Degener's Flora Hawaiiensis did not bring out the peduncles clearly, although he did show one very clearly on his original draft.

flowered."[5] Early in my study of *Stenogyne* it seemed that a key might be improved by avoiding such a basis of separation, because of its lack of sharpness. As the investigation proceeded, however, it became obvious that Hillebrand's method was probably as sound as would be found in the present state of our knowledge. Accordingly it was adopted.[6]

St. John's reduction of my *Stenogyne rugosa* var. *subulata* to *S. rugosa* may be considered here for the moment. *S. rugosa* was described by Bentham (Bot. Reg. sub *pl. 1292*, Tribo 6, num. 88. 1830) from Macrae's plant (Kew) and the calyces were said to be acutely dentate ("calycibus aridis acute dentatis"). Bentham later (in DC. Prodr. **12**: 556. 1848) had seen an additional plant by Menzies and rewritten his description of the calyces to read, "4–5 lin. longi, dentibus ovato-lanceolatis obtusis, 2 infimis brevioribus sed profundius fissis." He added that the leaves were oblong ("foliis . . . oblongis"). Hillebrand (Fl. Haw. Isls. 355. 1888) excluded *S. rugosa* from the portion of his key beginning "Calycine lobes linear or subulate" but placed it rather under the portion beginning "Calycine lobes not linear." Hillebrand described (op. cit. 356) the leaves as "ovate to ovate-lanceolate" and recorded that the trailing branches bore narrower leaves than did the erect ones. In my monograph (p. 66) I likewise described the leaves as "ovate to ovate-lanceolate." The calycine lobes I called "more or less lanceolate" and "acute." They should perhaps be described as "obtuse to acute" for some are indeed too broad to rank as acute. St. John finds fault with my key to the varieties and ends, as already stated, with reducing var. *subulata* to synonymy with the species proper. Unfortunately he limits his basis of study to certain specimens which I had cited for each entity. Not all of the material

[5] Under the first alternative he keyed *S. kaalae* and under the second, *S. rugosa*. Unfortunately, the peduncle often visible in *S. kaalae* and its variety can be noticed of course only in the cases that depart from the more common ones by having 4 or even 6 flowers per whorl.

[6] At one point (p. 29), St. John expands upon the art of making keys. We read: "The making of keys is an art, well mastered by some botanists but not by others. The excellence of the key is a good test of the finished quality of taxonomic work." Experienced monographers will of course not be deceived by the underlying innuendo of such lines. Generally speaking, "excellence of the key" is easy to secure for simpler and better understood genera and often difficult for the others. Moreover, it must be borne in mind that many of the genera monographed by me for the Hawaiian Islands were considered "the most difficult and intricate Hawaiian genera" by no less an authority than Otto Degener (Brittonia **5**: 58. 1943). Indeed, some of them (*Euphorbia, Labordia, Pittosporum*, etc.) had been persistently shunned by other workers because of the apparently insuperable difficulties involved. It would seem then that any dissertation, however brief, upon the subject of keys might well include additional considerations. We may charitably suppose that such considerations never occurred to St. John's mind. At all events, the difficulties encountered in certain of my keys to the more "difficult and intricate Hawaiian genera" were of necessity present, and at times to a greater degree, in earlier keys by such pioneers as Asa Gray and William Hillebrand. It seems too bad that these great men, long since dead and unable to utter a word in their own defense, must be thought of to-day as within the scope of St. John's censure.

cited by me for *S. rugosa* and the var. *subulata* is now accessible but most of the specimens reexamined separate readily enough if more attention is paid to the shape of the calyx-lobes, these tending to be, for var. *subulata*, not only "mostly exceeding the tube" (as stated in my key) but narrower and, at least above, "very sharply subulate" (as pointed out in my description). It seems probable that I erred in my monograph in referring some material (e.g., *Degener 5393*) to the species proper instead of to the variety *subulata*, thus confusing the situation all unintentionally for St. John. (It may be pointed out that St. John's study was not said to be a field-study but rather a reexamination of some specimens that had been cited by me.) It is to be hoped that other students may study the two forms in the field to see if indeed they are inseparable as stated by him.

COMPOSITAE

St. John discusses my treatment (Bull. Bish. Mus. **135**: 83–108. 1935) of of the genus *Dubautia* Gaud., particularly that of *D. plantaginea* and my variety of it, var. *Chamissonis*. He adduces what to him seem reasons for construing var. *Chamissonis* as synonymous with the species proper and forthwith equates the two. In the same paragraph, however, he renames the species proper, in its varietal sense, "var. *typica* St. John var. nov." If it be assumed that my var. *Chamissonis* was indeed the typical *D. plantaginea*, it is difficult to understand his inventing the new name *typica* for the variety already validly named *Chamissonis*. It is especially difficult since on an earlier page in the same paper (p. 22) St. John assures us all that "today we do taxonomic work in conformity with the detailed articles and recommendations of the International Rules of Botanical Nomenclature." Nowhere do the International Rules permit such random replacement of once validly published names for any status.[7]

A reexamination of the herbarium evidence, together with a painstaking reading of St. John's discussion, leaves me entirely unconvinced, however, that he has proved his case against var. *Chamissonis* as a variety apart from typical *D. plantaginea*. (1) I had said that *D. plantaginea* proper was "known only from the island of Lanai." St. John remarked, speaking of the voyage on which the type of the species itself had been collected, that "the Urania Voyage did not visit Lanai, so Gaudichaud could not have collected a species restricted to the mountains of the island." There was no warrant for his use of the word "restricted." As all advanced workers on the Hawaiian flora are aware, a certain proportion, not large to be sure, of the species or varieties found on Lanai are not "restricted" to that island

[7] The wisdom or unwisdom of establishing a fresh varietal name such as *typica*, as in this case, is not here under discussion. In the name of consistency, however, it does seem only fair that avowed devotees of the International Rules note concisely and openly those provisions of the Rules that they refuse to accept.

but occur on one or more of the other Hawaiian Islands. Many of these entities are of very local distribution and with the advent of increased population, introduction of domestic animals, etc., are exterminated on one or more of the islands. *D. plantaginea* proper is doubtless an example of this. Anyway, since Gaudichaud did not tell from which island his type had come and since the only more or less matching material available today was collected on Lanai, I could not well have cited the "known" present-day distribution differently.[8] (2) St. John refers to the only two collections (*Munro 48* and *Munro 271*) that I had cited for *D. plantaginea* in addition to the original type collection by Gaudichaud and stresses that they show traces of disease and injury. His implication seems to be that the distinguishing alternate (or in one case "subopposite") arrangement of the principal (i.e., lowermost) branches of the inflorescence is teratological. I have before me, however, a large photograph (my negative no. 2756) of an original Gaudichaud specimen (in Herb. Berl. and formerly studied by me) and this has the inflorescence with definitely alternate principal branches as portrayed in Gaudichaud's type plate, *but shows no evidence whatever of injury or disease*.[9] The fact, therefore, that modern Lanai material, even though somewhat teratological in its somatic tissues, exhibits the unique alternate arrangement observed originally in the Gaudichaud type collection, would seem to connote more than trivial value for this character. Nor in all the cited material of my var. *Chamissonis, several specimens of which had been affected likewise by injury or disease*, did I find any specimens where the principal branches of the inflorescence had been induced to depart from their opposite or essentially opposite arrangement. (3) St. John cites (p. 27) an apparent "oversight" on my part in my omission of Lanai as one of the islands on which var. *Chamissonis* grows, although I cited specimens for that island; also (p. 28) my including Kauai, Maui, and Hawaii in my "carelessly handled" statement of "geographic range" when no specimens from those islands were cited. My revision of *Dubautia* was published, it may be observed, by the Bishop Museum in remote Honolulu and a number of such errors crept into the final text as it was going through the press and

[8] Skottsberg, in a paper not cited by St. John (Meddel. Göteborgs Bot. 15: 508. 1943), rejected my var. *Chamissonis* partly because of reasoning akin to St. John's regarding Lanai, and partly because of having found some specimens (*Skottsberg 3686*) where the branches of the second pair were alternate. Touching this latter consideration, it need hardly be observed that a vast proportion of generally recognized varieties among vascular plants would have to be discarded if the existence of an occasional intergradation were to be accepted as the guiding criterion.

[9] Cf. Skottsberg (Meddel. Göteborgs Bot. Trädgård 2: 276. 1926). Skottsberg had studied this Berlin specimen. He wrote: "According to Gaudichaud the branches of the panicle are alternate, and so they are in this specimen which is, however, rather exceptional in this character." It will be noted that Skottsberg recorded no impression or suspicion that any injury or other teratological effect was involved.

being considerably overhauled at Honolulu to adapt it more exactly to the Bishop Museum's preferred style. Several very definite alterations in arrangement of text were made by the editorial assistants (such as shifting the "Distribution" paragraph to the end of the respective treatment), thus increasing the liability for error. I was afforded no opportunity to recheck the final page proof. It would seem, therefore, that St. John, himself a botanist and botanical adviser in editorial matters at Bishop Museum (even at the time my monograph was being dissected and "edited"), would be exceedingly cautious about attributing such errors to the author's own carelessness. However, in the ten years that have since elapsed, I have noted in my privately annotated copy all such errors as soon as detected. It is planned to publish a list of such *errata* later on. All additions to this list, from whatever source, will be welcomed. (4) In my monographic treatment of *Daubautia*, as the reader may have inferred, I separated var. *Chamissonis* as having "principal branches of panicle opposite" and *D. plantaginea* proper as having "principal branches of panicle alternate." I had seen several specimens of the former in which, at one or two lower nodes of the inflorescence's axis, one of two opposite branches had been stunted or actually broken off (although both of the subtending leafy bracts remained!), giving very superficially a slight semblance of alternate branching. St. John cites five collections having "the lower one to three nodes producing alternate branches." Since three of his five cited collections (*Fosberg 9007*, *Fosberg 10363*, and *Garber 140*) had been carefully studied by me (the two *Fosberg* numbers are now before me) and been found to be illustrative of this trifling departure, I cannot be seriously impressed with his reasoning. Surely his conclusion (p. 28) that alternate branching of the inflorescence "does not appear significant" will need much better evidence than he has offered.[10]

[10] It may be remarked that here (to judge from the three cited specimens seen by me) he has seized upon abnormalities of development in var. *Chamissonis*, these at times emphatically teratological, to justify a synonymizing of var. *Chamissonis* with typical *D. plantaginea*. And yet on an earlier page (p. 27), as we have already noted, he has sought to explain away the value of alternate principal (i.e., lowermost) branches of the inflorescence on the two modern specimens of *D. plantaginea* cited by me for Lanai, by stating that they had "injured main stems, and reduced panicles produced on the weak secondary branchlets." *Thus teratology or mere accidental injury, as the case may be, is now to be welcomed, now to be abhorred in the evaluation of diagnostic criteria.* But the case is less hopeless than it might seem, for St. John does admit the reliability of Gaudichaud's full-page plates. He says: "On gross detail they are excellent." He concludes that Gaudichaud was portraying a full-sized inflorescence, not one "from weak secondary branchlets, as in the two cited by Sherff." Of course, Sherff cited the only two modern specimens known to him as seeming to match the species proper, and was in no way to be blamed for their collector's having selected the somewhat injured sprays that he did. But even if we exclude these two plants by Munro from consideration, the handsome Gaudichaud plate and the Berlin specimen above referred to, both with all branches of the inflorescence *and their subtending bracts* regularly spaced in alternate arrangement, can in no way be said to show teratology, so there seems little point to much that St. John says.

(5) St. John follows his attack upon my treatment of *Dubautia plantaginea* with a further paragraph (p. 28): "The only remaining differences mentioned by Sherff are: *D. plantaginea* having the leaves 'at base more or less widened and clasping the stem'; var. *Chamissonis* having the leaves 'more or less narrowed toward base and semiamplexicaulous.' This sounds like the recognition of a broad leaved and a narrow leaved variant. Close study of the many cited specimens and of others shows no difference whatever. The qualifying phrase 'more or less' seems to make the words widened and narrowed, quite meaningless, as used by Sherff." It is difficult to understand how any competent taxonomist could fail to note at once the broader bases of the principal leaves on *D. plantaginea* proper. Indeed, Asa Gray (Proc. Am. Acad. **5**: 135. 1861) criticized Gaudichaud's plate of *D. plantaginea* proper for having the leaves "much too broad at the base." That was perhaps a pardonable error for Gray to make in his day, since the specimens in herbaria at his time were almost exclusively the ones with narrower leaf-bases and later separated by me as var. *Chamissonis*. In an effort, however, to learn if possible what basis might exist for St. John's criticism, I have reexamined all available material of var. *Chamissonis*. I find that this variety occasionally has a stunted shoot with the leaves crowded together at the base of a flowering branch or at the end of a sterile branch. In such cases the leaves may have broad bases. On flowering branches of normal development, however, i.e., with average-length internodes among the leaves, the leaf-bases are commonly narrow.

St. John cites the portion of my key in which *D. plantaginea* and its var. *Chamissonis* are separated from the var. *angustifolia*, once described by me. He then remarks: "Neither a first nor a repeated reading of those lines will reveal any tangible key characters. A key should single out diagnostic differences, but this one fails to do so." Much will depend, I fear, upon who reads the key. It must be emphasized that the cited key was written seriously for sincerely minded botanical workers and went as far in its characterizations as the facts at hand and the state of our knowledge of the genus at that time seemed to warrant. To quote a portion of the text repeated by St. John:

> "a. Principal leaves . . . commonly 1–3.4 cm. wide. . . .
> a. Principal leaves . . . 0.7–1.3 (rarely – 1.6) cm. wide . . . var. γ angustifolia."

It seems to the present writer that any unbiased student would deem 1.3 or even 1.6 cm. maximum width for the leaves a tangible key character as against 3.4 cm. Unfortunately one specimen (*Fosberg & Duker 8795*) cited by me for var. *angustifolia* had the larger leaves and doubtless should have been referred to var. *Chamissonis*. But the other cited specimens were definitely narrow-leaved. It happened that for the var. *anguustifolia* I had to rely more often upon a single specimen of any one collection, rather than

upon a large suite of specimens (sometimes totaling 30 or 40 or more in the case of plants collected by Otto Degener and his associates). There was thus less opportunity to study a range of leaf-width variations. It is my present judgment, however, after a reexamination of the present collection at the Chicago Natural History Museum (including large photographs of several specimens previously cited by me from elsewhere), that var. *angustifolia* will probably stand as a good variety. This despite St. John's reduction of it, as of var. *Chamissonis*, to synonymy with *D. plantaginea*. We may note in passing that St. John (p. 29) makes much of my words for var. *angustifolia*, "bracts (leaves) more elongate" and denies that this is so. Reference to my original description of the variety (Am. Jour. Bot. **20**: 616. 1933) shows that these four words were absent, as they rightly should have been. How they came to be inserted in my monograph when it was printed by Bishop Museum I do not know. They are of course wrong and I cannot believe that they were a part of my own manuscript, long since destroyed. We may note, further, that St. John (p. 29) complains that "var. *angustifolia* has no distinct geographic range." In the Hawaiian Islands, endemism is many times pronounced and there result many separate, restricted geographic ranges. A study of ranges thus becomes a major consideration in the delimitation of new taxonomic entities. It has always played an important part in my own studies of Hawaiian genera. It is not, however, the only consideration, nor even the greatest. Morphology is after all more important and unless subsequent study by other observers reveals a noteworthy inconstancy in the narrow-leaved character for var. *angustifolia*, the variety's status as such surely will have been vindicated. At this point it may be remarked that while my cited material of var. *angustifolia* consisted mostly of unicates, my cited material of var. *Chamissonis* (with which St. John equates it for the moment) included several, often large suites of specimens (e.g., *Degener 4325*, 7 specimens; *Degener 4333*, 12 specimens; *Degener 4337*, 4 specimens; *Degener & Park 4338*, 2 specimens; *Degener & Park 4342*, 9 specimens). In these suites (numerous additional specimens of which were left uncited by me and returned to Degener for later distribution with his other exsiccatae to various herbaria), I failed to find any significant intergrading in leaf-width character with var. *angustifolia*.

In my revisional treatment of *Dubautia*, I had included var. *strigosa* Skottsb., citing the islands of Oahu, Maui, and Hawaii for the geographic distribution. St. John (p. 30) separates the Oahu material as a new variety, *pauoaensis*, and the Maui material as a new variety, *glandulosa*. It is not my intention now to express opinion upon the validity of these two newly proposed varieties. It should be stated, however, that Skottsberg (op. cit. 277) had already noticed the Maui plants, but construed them as merely a form of his then new var. *strigosa*. Thus he wrote: "A very similar form (Fig.

7 e–g) was collected by Hillebrand on E. Maui, s. slope of Haleakala. . . . It differs from most specimens seen, of both species and variety, in the smaller number of flowers, only 5 to 6 or sometimes 7, against 7–9 which is the common number." Curiously, Skottsberg and St. John both examined and cited Hillebrand's material from East Maui, yet Skottsberg noted only the fewer florets per head and St. John (who made no mention of Skottsberg's earlier observation) omitted this character entirely but stressed mainly the smaller involucral bracts. By way of explaining my own monographic treatment of var. *strigosa* in its broader sense, I may add here a few brief remarks. Skottsberg was at that time (1935) easily the best known authority upon the genus *Dubautia*, having made extensive collections of *Dubautia* in 1922 (some seven years before St. John's residential study of the Hawaiian flora began) and again in 1926, and having published considerable text, illustrated with three series of excellent sketches (op. cit., 276–281, *figs. 7 a–h*, *8 a–i*, and *9 a–g*). I was much impressed with his appraisal of the East Maui plant as "a very similar form," apparently not meriting a distinct status. I naturally attributed to the lone Oahu collection cited by St. John for his new var. *pauoaensis* (*Rock 215*) a comparable value and so retained it, as well as the East Maui plant, under var. *strigosa* Skottsb.

CHICAGO TEACHERS COLLEGE
AND
CHICAGO NATURAL HISTORY MUSEUM
CHICAGO, ILLINOIS

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 194–202 MARCH, 1946

THE GILIA AGGREGATA GROUP

EDGAR T. WHERRY

Elongated clusters of bright red trumpet-flowers on two-foot stalks clothed below with lacy foliage attract the attention of layman and naturalist alike in many parts of the western United States. Exhaling a mephitic odor, these plants are inacceptable to grazing animals, and may become abundant even in well-pastured areas. They are known locally as "ruby honeysuckle," "scarlet bugler," or "skyrocket"; the Indians,[1] among other names, used "timpiute." A specimen was collected in what is now Idaho by the Lewis and Clark expedition in 1806, and named by Pursh in 1814 "Cantua aggregata," but the current assignment is to a section *Ipomopsis* of the genus *Gilia*. To obviate the need for publishing numerous new combinations, this is followed here, although the generic independence of *Ipomopsis* may some day be accepted.

The "timpiutes" vary markedly from place to place in stature, pubescence, leaf-segment outline, length and extent of union of sepals and petals, shape of sepal- and petal-blades, color of petals—from deepest red to purest white,—and length of stamens. Some taxonomists consider all the variants to constitute a single species with multiple subdivisions, while others separate the complex into several species.[2]

The principal exponent of the multi-species viewpoint was Greene, who in his writings of 1905, 1906, and 1914 recognized no less than twelve. His diagnoses were, however, brief, and did not always correspond closely to the features of the type specimens. In contrast, Brand in 1907 erected a complex "Systema speciei" comprising 2 subspecies, 2 varieties, 2 subvarieties, and 3 forms. He classed many of Greene's entities as equivalents of previously known ones, but as he paid little attention to original descriptions or type specimens his conclusions are not dependable. Since sweeping reduction of epithets to synonymy is likely to obscure interesting relations between morphology and geography, all which have been validly published are accorded a place in the present treatment.

[1] Indian names and uses of these plants are discussed in: Train, et al., Medicinal uses of plants by Indian tribes of Nevada. Contr. Flora Nevada No. 33, Publ. Div. Pl. Expl. Intr. Bur. Pl. Ind. U. S. Dep. Agr. pt. 2: 76. 1941.

[2] The generalization by Jepson in Flora Calif. 3(2): 174 (1943), that "*Gilia aggregata* is an extremely constant species in vegetative organs and in the character of its flowers" is difficult to reconcile with its segregation by various workers into 15 or more species. It can easily be refuted by close examination of the sheets in the *Gilia aggregata* folders in any herbarium.

Field and herbarium study of the group soon showed that there are several geographic trends, exhibited especially in calyx and corolla characters. In spite of the existence of occasional intermediates, then, the recognition of more than one species seemed desirable. The members with relatively slender corolla-tube and pale corolla-hue proved to be separable into four entities differing in corolla and/or calyx characters; and those with flaring tubes of bright red hue into three more. The epithets applicable to these are: *aggregata* for the most widespread; *arizonica* for a Nev.–N.M. endemic; *attenuata* for a chiefly northern assemblage; *bridgesii* for a Calif. endemic; *candida* for a Colo.–N.M. one; *tenuituba* for a Great Basin assemblage; and *texana* for a dominantly southern assemblage. More or less intergradation admittedly occurs between these, especially where ranges overlap; it seems to be largely the result of hybridization. To attempt to allow for it nomenclatorially would yield aggregations of epithets too complex for practical use.

The nomenclatorial and taxonomic procedures followed in recent papers by the writer are continued here. Subspecies are assigned trinomials without interposed category designation. The only other infra-specific category recognized is that of form; these are referred to primarily by vernacular descriptive terms, although epithets applied to them by previous workers are recorded. Species and infraspecific epithets are decapitalized, no matter what their derivation.

An annotated alphabetical list of the epithets which have been applied to the members of the group under discussion is now given; new combinations are placed in bold-face, earlier ones proving acceptable in italic or small capitals, and rejected ones in ordinary type, enclosed in quotation marks. To save repeating long references, Greene's *Leaflets of Botanical Observation and Criticism* is abbreviated to "Leafl." and Brand's Monograph on *Polemoniaceae* in Engler's *Pflanzenreich* IV 250 to "Pol."

In describing organs showing coalescence of parts the customary pre-evolutionary method of statement, e.g., "calyx cleft to $\frac{1}{3}$ its length," is avoided. Instead, the extent of union of sepals and petals is given, their free parts being then termed the blades.

For duplicate sheets bearing the same number as the holotype the term replicate is used instead of the more familiar "isotype." The latter implies that a collector or distributor has seen to it that multiple sheets with a given number carry specimens of the very same entity, whereas in critical groups like the *Polemoniaceae* this not infrequently fails to be done.[3]

[3] Earlier botanists, according to Jackson's *Glossary*, used isotype for "forms common to different countries." In 1919 Pennell, in Torreya 19: 13, redefined the term to signify sheets bearing the same number as the holotype. He pointed out that "such a term should emphasize the importance of all duplicates being thoroughly like the type"; but unfortunately there is no way to make this retroactive, nor to enforce its application.

EPITHETS PROPOSED IN THE GILIA AGGREGATA GROUP

(Comprising Gilias of biennial duration, dissected leaves, thyrsoid inflorescence, and relatively large funnel-salverform corollas of red, yellow, pink, or white hues, the petal-blades acuminate to obtusish.)

AGGREGATA (Pursh) Spreng. "Cantua aggregata" Pursh, Fl. Am. Sept. **1**: 147. 1814; "Ipomeria aggregata" Nutt. Gen. N. Am. Pl. (1): 124. 1818; *Gilia aggregata* Spreng. Syst. Veg. (16) **1**: 626. 1825; "Batanthes aggregata" Raf. Atl. Jour. **1**(4): 145. 1832; "Collomia aggregata" Port. apud Rothr. Rep. U. S. Geogr. Surv. w. 100° **6**: 198. 1878; "Callisteris aggregata" Greene, Leafl. **1**: 159. 1905; same, reinterpreted, ibid.: 224. 1906. The type specimen, *Lewis*, June 26, 1806, in the American Philosophical Society herbarium deposited at the Academy of Natural Sciences of Philadelphia, is a wretched scrap. Its herbage is pubescent with both copious minutely glandular and sparse long eglandular hairs. The sepals are 6 mm. long, and united $\frac{2}{5}$ their length to a subcampanulate tube, the blade broad-subulate and short-aristate. The petals are red, and before drying were apparently about 20 mm. long and united $\frac{2}{3}$ their length to a moderately thick and flaring tube, the blade being lanceolate and acuminate. Stamens and styles are included, although Pursh's characterization of the style as "brevissimo" represents a misobservation. Through inadvertence the locality was published as "On the banks of the Mississippi"; no doubt "Missouri" was intended, but even that would have been in error; for the label reads "Hungry Creek." This was a point on the Lolo Trail at latitude 46°30′ longitude 115°10′ in what is now Idaho, across the divide from the tributaries of the Missouri.

ARIZONICA (Greene) Rydb. "Callisteris arizonica" Greene, Leafl. **1**: 160. 1905; "Batanthes arizonica" ibid.: 224. 1906; "Gilia aggregata euaggregata subvar. arizonica" Brand, Pol.: 115. 1907; *Gilia arizonica* Rydb. Bull. Torrey Club **40**: 472. 1913; "G. aggregata var. arizonica" Fosb. Am. Midl. Nat. **27**: 764. 1942. The type is from Flagstaff, Ariz. (35–12, 111–39), *Macdougal 148*, May 26, 1891, in U. S. Nat. Herb. Several other entities were distributed from that locality by him. The entity represented by the type is characterized by short broad sepal-blades, short corollas, and deeply included stamens.

ATTENUATA (Gray) Nels. "Gilia aggregata var. attenuata" Gray, Syn. Fl. N. A. (2)**1**: 145. 1878; *Gilia attenuata* Nels. Bull. Torrey Club **25**: 278. 1898; "Callisteris attenuata" Greene, Leafl. **1**: 160. 1905; "Batanthes attenuata" ibid.: 224. 1906; "G. aggregata euaggregata var. attenuata" Brand, Pol.: 115–116. 1907. The type is a specimen collected by Parry in 1864 in Middle Park, Colo. (ca. 40–15, 106–15), in Gray Herb.; others of his collections there are different entities. The typical representative has the sepals about half united and a pale corolla with a short, slender tube and lanceolate-attenuate blades.

(aurea.) "Gilia aggregata f. aurea" Macbr. & Pays. Contr. Gray Herb. **49**: 64. 1917. Type from Martin, Idaho (43–31, 113–34), *Macbride & Payson 3082*, July 7, 1916 in Gray Herb. This represents a yellow color-form which is occasional in southern Idaho and rare elsewhere. Having exserted stamens, it is to be assigned to: *Gilia aggregata formosissima* f. **aurea** (Macbr. & Pays.) Wherry, comb. nov.

"australis." This epithet, placed on labels by Heller, was merely cited as a synonym of his "Gilia aggregata euaggregata subvar. arizonica" by Brand, Pol.: 115. 1907, so is not validly published. As type was designated a sheet of *Macdougal 52*, June 4, 1888, from Flagstaff, Arizona (35–12, 111–39), in Delessert Herb. Replicates in American herbaria bear specimens of *G. arizonica*, of *G. texana*, of *G. aggregata*, or of intermediates (hybrids?) between these. The epithet need not be validated.

Gilia bridgesii (Gray) Wherry, comb. nov. "G. aggregata var. bridgesii" Gray, Proc. Am. Acad. **8**: 276. 1870; "Callisteris bridgesii" Greene, Leafl. **1**: 160. 1905; "Batanthes bridgesii" ibid.: 224. 1906; "G. aggregata bridgesii" Brand, Pol.: 115–116, 1907. Type from eastern Mariposa county, Calif. (ca. 37–45, 119–35), *Bridges 174*, in Gray Herb. In the original description, Gray characterized the sepal-blades as "lato-subulatis immo deltoideis"; in the Syn. Fl. **2**(1): 145 (1878) he expanded this to "shorter and broader, from subulate-lanceolate to deltoid." Brand rendered it simply as "breviter triangulares." The type of sepal-blade to which they were referring is characteristic of species other than *G. aggregata*. However, the present entity differs from all other members of the group in lax habit, obtusish leaf-segments, narrowly deltoid barely awned sepal-blades, and pink corolla with the petals united $\frac{3}{5}$ to $\frac{3}{4}$ their length to a moderately slender tube. As it is, moreover, endemic in a restricted area in east-central California, Greene's view that it deserves species status is believed to be justified. Its closest relative appears to be *Gilia texana*, which approaches its range on the northeast.

CANDIDA Rydb. Bull. Torrey Club **28**: 29. 1901; "Gilia aggregata euaggregata var. attenuata f. candida" Brand, Pol.: 115–116. 1907; "G. attenuata synonym" Coult. & Nels. Man. Rocky Mts.: 400. 1909. Type from La Veta, Colo. (37–30½, 105–00½), *Vreeland 602*, 1900, whereabouts unknown. Cotypes are characterized by having the sepals united $\frac{3}{5}$–$\frac{3}{4}$ their length, the blades being at first rounded, then abruptly contracted to a broad-subulate aristate tip; and the white to pink corolla long, slender-tubed, with elliptic (or according to Rydberg obovate) and obtusish petal-blades. These characters are regarded as sufficient to separate this entity from its nearest relative, *Gilia attenuata*. It falls into two subspecies; the original one may be known as: *Gilia candida* **vera** Wherry, nomen novum pro plantam originariam.

(collina.) "Callisteris collina" Greene, Leafl. **1**: 159. 1905; "Batanthes collina" ibid.: 224. 1906; "Gilia aggregata synonym" Brand, Pol.: 115. 1907; "G. attenuata synonym" Coult. & Nels. Man. Rocky Mts.: 400. 1909; "G. attenuata collina" Ckl. ex Dan. Univ. Mo. Stud. Sci. **2**(2): 197. 1911. Type from Clear Creek, Denver, Colo. (39–49, 105–00), *Greene*, July, 1870, in Greene herbarium. This is not closely related to either of the species of which it has been made a synonym, but intergrades with a third, so is here classed as *Gilia candida* **collina** (Greene) Wherry, stat. nov. It may represent a hybrid with *G. texana*. See "G. greeneana," below.

(elegans.) A figure published by Lindley, Bot. Reg. **15**: *pl. 1281* (1829), under the name "Ipomopsis elegans," represents not the eastern plant so named by Michaux, but the western *Gilia aggregata formosissima.*

(euaggregata.) *Gilia aggregata euaggregata* Brand, Pol.: 115. 1907. In assigning the third epithet to the subspecies including the type, Brand gave no description. It is here accepted for material with the corolla-tube 20 to 30 mm. long and the stamens included.

(flavida.) "Callisteris flavida" Greene, Leafl. **1**: 160. 1905; "Batanthes flavida" ibid.: 224. 1906; "Gilia aggregata synonym" Brand, Pol.: 115. 1907. Type from Arboles, Colo. (37–01, 107–23½), *Baker 532* in U. S. Nat. Herb.; this is a specimen of *Gilia texana* with red corollas which faded more or less to yellow in press. It may be known as *Gilia texana* f. **flavida** (Greene) Wherry, stat. nov.

(formosissima.) "Callisteris formosissima" Greene, Leafl. **1**: 160. 1905; "Batanthes formosissima" ibid.: 224. 1906; "Gilia aggregata synonym" Brand, Pol.: 115. 1907; "G. formosissima" Woot. & Standl. Contr. U. S. Nat. Herb. **16**: 161. 1913. Type from southern Black Range, N. M. (32–55, 107–45) *Metcalfe 1318*, 1904, in U. S. Nat. Herb. As this differs from the original representative in having conspicuously exserted stamens, it is here made: *Gilia aggregata* **formosissima** (Greene) Wherry, stat. nov. Only subspecies status is admitted because there is complete intergradation in respect to stamen-length, and but little geographic segregation: exserted-stamen plants are more frequent westward, but may appear throughout the species range.

"greeneana" Woot. & Standl. Contr. U. S. Nat. Herb. **16**: 161. 1913. This was put forward as a substitute for "Callisteris collina" Greene and would be accepted were the entity concerned taken up as a species of *Gilia* (there being a prior *G. collina*, belonging to another group). Only subspecies status is here recognized, however, and in that the epithet *collina* is available.

(helleri.) "Gilia aggregata euaggregata subvar. helleri" Brand, Pol. 115. 1907. Type from Lake Waha, Idaho (46–12, 116–50) *Heller 3253*, in Boissier Herb. Replicates in American herbaria consist of variants of *G. attenuata*, with the stamens barely included to barely exserted. The entity deserves only the status: *Gilia attenuata* f. **helleri** (Brand) Wherry, stat. et comb. nov.

(leucantha.) "Callisteris leucantha" Greene, Leafl. **1**: 160. 1905; "Batanthes leucantha" ibid.: 224. 1906; "Gilia aggregata euaggregata var. attenuata f. candida synonym" Brand, Pol.: 116. 1907; "G. attenuata synonym" Coult. & Nels. Man. Rocky Mts.: 400. 1909. Type from Upper Bear Creek, Colo. (39–36½, 105–29) *Greene*, July 26, 1889, in Greene herbarium. This is a minor variant of the species with long well-united sepals, distinguished only by its "oblong-acutish" petal-blade, so may become: *Gilia candida vera.* f. **leucantha** (Greene) Wherry, stat. nov.

(macrosiphon.) "Gilia aggregata var. macrosiphon" Kearn. & Peeb. Jour. Wash. Acad. **29**: 488. 1939. Type from Santa Catalina Mts., Ariz. (32–25, 110–45), *Peebles et al. 2522*, July 22, 1926, in U. S. Nat. Herb. This is related not to *G. aggregata* but to *G. tenuituba;* differing from the original representative of that only in the somewhat longer corolla, it should be classed as *Gilia tenuituba* f. **macrosiphon** (Kearn. & Peeb.) Wherry, stat. et comb. nov.

(maculata.) "Gilia aggregata var. maculata" Jones, Contr. W. Bot. **12**: 55. 1908. Type from Soldier Canyon, Chihuahua (30–15, 108–15), *Jones*, Sept. 16, 1903, in Pomona College herbarium. Being a minor color-variant, this may become: *Gilia aggregata formosissima* f. **maculata** (Jones) Wherry, stat. nov.

"pulchella" Dougl. ex Hook. Fl. Bor. Am. **2**: 74. 1838; "Callisteris pulchella" Greene, Leafl. **1**: 160. 1905; "Batanthes pulchella" ibid.: 224. 1906; "Gilia aggregata synonym" Brand, Pol.: 114. 1907. Type from lower Spokane River, Wash. (47–53, 118–20), *Douglas*, 1825, in Kew Herb. The sole differentiating feature given in the original description is arachnoid pubescence. Although the writer once, in Graham, Ann. Carn. Mus. **26**: 303 (1937), accepted this as a species distinction, further study has indicated it to be of sporadic occurrence among glabrate material. It is accordingly here reinterpreted as *Gilia aggregata euaggregata* f. **pulchella** (Dougl. ex. Hook.) Wherry, stat. nov.

"scariosa" Rydb. Bull. Torrey Club **31**: 632. 1904; "Gilia aggregata synonym" Brand, Pol.: 115. 1907. Type from Veta Pass, Colo. (37–36, 105–12), *Shear 3590*, July 15, 1896, in Britton Herb. This differs from *G. candida* (the type of which came from the same vicinity) only in the petal-blades being lanceolate; the intersepaline membranes of all members of the group become more or less scarious in age. It may therefore become *Gilia candida vera* f. **scariosa** (Rydb.) Wherry, stat. nov.

(scopulorum.) "Batanthes scopulorum" Greene, Leafl. **1**: 224. 1906; proposed as a substitute for "Callisteris aggregata Greene, probably not Cantua aggregata Pursh." Greene inferred that distinct entities were involved, in that Pursh's type "came from the Pacific slope," whereas Greene was referring to a plant "from the Rocky Mountain region eastward." The geographic separation is much too slight to make species identity improbable, so Greene's proposal is rejected.

TENUITUBA Rydb. Bull. Torrey Club **40**: 472. 1913. Type from Beaver, Utah (38–17, 112–39), *E. Palmer 329*, 1877, in Britton Herb. While closely related to *G. attenuata*, this has the longest corolla in the group, so deserves species status.

TEXANA (Greene) Woot. & Standl. "Callisteris texana" Greene, Leafl. **1**: 160. 1905; "Batanthes texana" ibid.: 224. 1906; "Gilia aggregata euaggregata subvar. arizonica equivalent" Brand, Pol.: 115. 1907; *G. texana* Woot. & Standl. Contr. U. S. Nat. Herb. **16**: 161. 1913; "G. aggregata var. texana" Johnston, Jour. Arnold Arb. **24**: 95, 1943. Type from Guadelupe Mts., Tex. (31–55, 104–50) *Havard*, Sept., 1881, in U. S. Nat. Herb. This entity has been poorly described. Greene termed it "low," but the type specimen is a broken portion of a tall plant; he characterized the calyx as "herbaceous," but in mature flowers it is subscarious; and he classed the corolla as "smallish," whereas it is actually 35 mm. long. Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 525 (1915), keyed it out as having the "lobes of the calyx equaling the tube," although in the type specimen they are shorter. The corolla is bright red and flaring, with the stamens conspicuously exserted as in *G. aggregata formosissima;* but because of the different calyx,—sepals only 5.5 mm. long, united over half their length, the blades deltoid with subulate tip—it is here considered specifically distinct.

(typica.) The epithet "typica" was used by Brand, Pol.: 115. 1907, in varietal status under *Gilia aggregata euaggregata,* although the data he gave were not in accord with the type specimen. This epithet was placed on the labels accompanying specimen No. 745 of the Plantae Exsiccatae Grayanae, but the material was not like the Pursh type, representing instead *G. arizonica.*

(utahensis.) "Gilia aggregata euaggregata var. attenuata f. utahensis" Brand, Pol.: 115–116. 1907. Type from Alta, Utah (40–35½, 111–38), *Jones 1122,* July 31, 1879, presumably destroyed in the Berlin-Dahlem herbarium. In such case, the replicate in the Gray Herb. may be taken as neotype. As this differs from other long-tubed material only in slightly longer sepals, it may become *Gilia tenuituba* f. **utahensis** (Brand) Wherry, comb. nov.

(ventrensis.) "Gilia aggregata euaggregata var. attenuata f. ventrensis" Brand, Pol.: 115–116. 1907. The type specimen of this, *Howard 186* from the Gros Ventre valley, Wyoming (ca. 43–30, 110–13), was mistakenly stated to be in the Gray Herbarium, and neither it nor any replicate has been seen. The description indicates it to be a minor variant, with subexserted stamens, so it may become: *Gilia attenuata* f. **ventrensis** (Brand) Wherry, comb. nov.

(vera.) Subspecies *vera* was applied above to the original *Gilia candida.*

(violacea.) "Callisteris violacea" Greene, Rep. Spec. Nov. **13**: 324. 1914; "Gilia aggregata equivalent" Dayton, Bull. Torrey Club **55**: 71. 1928. Type from Montezuma Nat. For., Colo. (ca. 37–30, 108–10), *U. S. For. Serv. 11544,* in U. S. Nat. Herb. Having a long narrow corolla-tube, this color-form may be known as: *Gilia tenuituba* f. **violacea** (Greene) Wherry, stat. nov.

KEY TO THE GILIA AGGREGATA GROUP

(based on measurements of flowers in mid-anthesis)

LEAF-SEGMENTS obtusish; habit lax; sepals united ½–⅔ their length of 5–7 mm., the blade narrow-deltoid, barely awned; corolla pink, 30–45 mm. long; petal-blade oblong; stamens included or barely exserted. Endemic in east-centr. Calif., lat. 36°15′ to 39°. 1. *G. bridgesii.*

LEAF-SEGMENTS acutish; habit strict (or lax in mutants).

CALYX cylindric, the sepals united ⅔–¾ their length of (6) 8–10 mm., the blade obtuse, abruptly contracted to a subulate-aristate tip; petals united ¾–⅘ their length of (25) 30–45 mm. Endemic in Colo. and adj. N. M., long. 108° to 112°. 2. *G. candida;* ssp.:

COROLLA-HUE white to pink; tube little expanded upward; blade obtusish to acutish and oblong (f. *leucantha*) to lanceolate (f. *scariosa*). a. *vera.*

COROLLA-HUE deep pink to red; tube more or less expanded upward; blade lanceolate. Apparently mostly of hybrid origin. b. *collina.*

CALYX subcampanulate; sepal-union not over ⅔ the length.

COROLLA-TUBE slender with but slight upward expansion; hue pale or rarely deep; sepal-blades broad- to narrow-subulate.

COROLLA-LENGTH 25–30 (35) mm.; hue white, yellow, or pink; stamens included to subexserted (f. *helleri*, f. *ventrensis*); sepals united ⅓–½ their length of 5.5–9 mm., usually rather long-awned. Range from ne. Wash. to centr. Colo. 3. *G. attenuata.*

COROLLA-LENGTH (30) 35–60 mm. (f. *macrosiphon*); hue white to pink, sometimes purple-streaked or becoming violet on drying (f. *violacea*); sepals united ⅔–¾ their length of 5.5–9 mm. (f. *utahensis*), usually rather short-awned. Range from e. Calif. to w. Colo. 4. *G. tenuituba.*

COROLLA-TUBE stout, with marked upward expansion, 20–45 mm. long; hue deep red more or less mottled with yellow; pink or yellow in mutants.

SEPAL-UNION ½–⅔ the total length of 4 to 6 (8) mm., the blade deltoid to oblong, more or less abruptly contracted to a subulate tip 0.5–3.5 mm. long, barely to moderately awned.

PLANT tall, (30) 40 to 100 cm. high, often sparse-pubescent; corolla red or drying yellow (f. *flavida*); (27) 30–40 mm. long; stamens more or less exserted. Range n. Calif. to ne. Mex. 5. *G. texana.*

PLANT dwarf, 15–30 (50) cm. high, often dense-pubescent; corolla red, 20–25 (30) mm. long; stamens more or less deeply included. Endemic from s. Nev. to n. N. M. 6. *G. arizonica.*

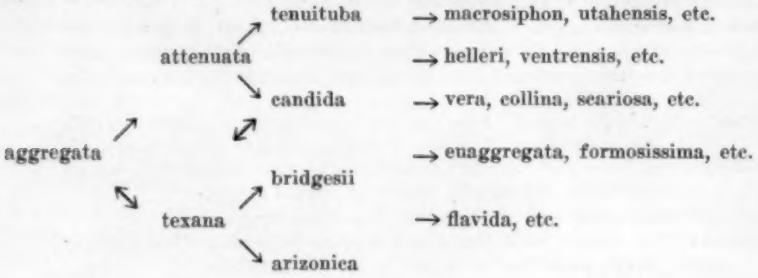
SEPAL-UNION less than half the total length of 6–9 mm., the blade subulate from a more or less broad base, moderately awned. Range, s. B. C. to centr. Mex. 7. *G. aggregata;* ssp.:

STAMENS included; corolla red, yellow-mottled, or rarely yellow; 20–30 (35) mm. long; herbage glabrate to tomentose (f. *pulchella*). More frequent toward east side of range. a. *euaggregata.*

STAMENS exserted; corolla red, yellow-mottled (f. *maculata*) or yellow (f. *aurea*) (25) 30–45 mm. long. More frequent toward west side of range. b. *formosissima.*

EVOLUTIONARY RELATIONS

The key presented on the preceding page is frankly artificial, the sequence of entities being such as to make diagnosis as easy as practicable. The evolutionary relations between the various entities involved can, however, be brought out by a tabulation as in the accompanying chart.



Anyone desiring to recognize fewer species than are accepted here will do well to carry out status-reduction in the directions indicated by the arrows.

Relationship of G. aggregata to G. rubra. The closest relative of the entities above discussed is *Gilia rubra* (L.) Heller, otherwise *Ipomopsis rubra* (L.) Wherry. This is a more eastern plant, ranging from Texas to Florida, and its nomenclature has been discussed in the writer's series of studies on eastern *Polemoniaceae*.[4] In proposing the genus epithet "Callisteris" for *G. aggregata* and its allies, Greene[5] stated: "From the *Ipomopsis* of Michaux, itself an excellent genus and monotypic, they differ not only habitally and in foliage, but widely in character of calyx and seeds." It is difficult to account for these assertions. *Gilia rubra*, the *Ipomopsis* of Michaux, is remarkably similar in habit to *G. aggregata*, merely lacking glandular pubescence and having filiform leaf-segments. Measurements of the calyx on some 25 specimens show its length to average 8 mm. and the subulate sepals to be united $\frac{2}{3}$–$\frac{1}{2}$ their length, essentially as in *G. aggregata*. The seeds of some forms of *G. rubra* are, it is true, unchanged when moistened, yet in other forms unquestionably belonging to the same species the seed-coat becomes nearly as mucilaginous as in *G. aggregata*. It can only be concluded that Greene exaggerated the dissimilarities, and that whatever generic assignment is ultimately settled upon, *G. rubra* and the *G. aggregata* group will be considered congeneric.

DEPARTMENT OF BOTANY, UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA, PENNSYLVANIA

[4] Bartonia No. 18: 56. 1936.
[5] Leaflets Bot. Obs. & Crit. 1: 159. 1905.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 73, NO. 2, PP. 203–207 MARCH, 1946

TORREYA

SHORT ARTICLES AND NOTES

Notes on the Grasses, Sedges and Rushes of the Great Swamp (New Jersey).[1] During the spring and summer of 1944 the authors collected all mature grasses which they could find growing in the survey area of the Great Swamp.

The Great Swamp lies in Chatham Township, Morris County, south of the town of Chatham. The survey area is a half mile square. The northern boundary starts at the point where the Public Service high power line crosses Southern Boulevard and follows the latter one-half mile west. The eastern boundary runs south from Southern Boulevard one-half mile along the high power line. The northern portion of the area is on the Wisconsin terminal moraine where the soil is a sandy loam with a pH of 5.17 in the open fields. As one goes south through the area and down into the swamp proper, the soil becomes a black silt which in certain areas is in the early stages of peat formation with a pH as low as 4.19.

All of the specimens were determined by Mr. Bayard Long of the Academy of Natural Sciences of Philadelphia. The specimens are in the Rapp Herbarium, the Chrysler Herbarium at Rutgers University, and the Academy of Natural Sciences of Philadelphia.

GRAMINEAE

The grasses growing in the Great Swamp are cosmopolitan species growing throughout the eastern United States. Many of the grasses might be called prairie species, since they are common in the prairie region of Middle North America.

The sequence of tribes and genera follows that of Hitchcock's "Manual of Grasses of the United States."

Festuceae. Fescue Tribe

POA COMPRESSA L. Canada Bluegrass. Found everywhere except in the dense woodland and in the very wet places. We took mature specimens 28 June 1944.

TRIODIA FLAVA (L.) Smyth. Favors open fields and woods. It is common on the midwestern prairie. Mature specimens were taken 2 September 1944.

Oryzeae. Rice tribe

LEERSIA VIRGINICA Willd. Common in the damp woods and along the paths. Mature specimens were taken 13 August 1944.

Paniceae. Millet Tribe

PANICUM MICROCARPON Muhl. A woodland species prefering acid soil. Mature specimens were taken 28 June 1944.

PANICUM DICHOTOMUM L. Found in the open areas, especially on the moraine where the soil is sandy. Mature specimens were taken 28 June 1944.

[1] Fourth contribution to the Great Swamp Ecological Survey.

PANICUM LINDHEIMERI var. FASCICULATUM (Torr.) Fernald. Common in moist places near the bottom of slopes. Mature specimens were collected 28 June 1944.

Andropogoneae. Sorgum Tribe

ANDROPOGON SCOPARIUS Michx. Prairie Beardgrass. Common in the open fields in the northern part of the survey area. Mature specimens were collected 2 September 1944.

CYPERACEAE

We collected two genera from the Great Swamp, *Scirpus* and *Carex*. Most of the species are widely enough distributed to occur in the prairie region as well as in the eastern United States.

The arrangement here follows that of Deam's "Flora of Indiana."

SCIRPUS ATROVIRENS Muhl. Common on wet mucky soil. Specimens were collected 28 June 1944.

CAREX ANNECTENS Bickn. Collected in the drier areas of the Swamp particularly where the soil was more acid. Mature specimens collected 28 June 1944.

CAREX SCOPARIA Schkuhr. This species seemed to prefer open wet areas in the swamp. Specimens were collected 28 June 1944.

CAREX STRICTA Lam. Found in wet places both in open regions and under trees. We collected mature specimens 30 July 1944.

JUNCACEAE

JUNCUS EFFUSUS L. Found in low portions of fields and in wet open woods. Mature specimens were taken 28 June 1944.

JUNCUS TENUIS Willd. A coastal plain species which has migrated back into the Piedmont plain. Mature specimens were taken 28 June 1944.

LUZULA ECHINATA (Small) Hermann. Fairly common in the open woods on drier slopes. Mature specimens were collected 28 June 1944.—WILLIAM F. RAPP, JR. AND JANET L. C. RAPP.

Additional Introduced Plants in the Aleutian Islands.[1] Considerable interest attends the introduction of plants into the Aleutian Islands, because conditions there suggest that these islands could support a better flora than they now possess. Until recently few attempts have been made to introduce plants except for some scattered planting of trees in the eastern end of the chain. There are a few of the ubiquitous weeds which have inevitably come along whenever the few white inhabitants have undertaken agriculture. The attempts to introduce trees have been ably summarized in a recent article in the Geographical Review for July, 1945,[2] with some data on weather conditions bearing on their survival possibilities.

It is usually necessary in studying introduced plants to search out-of-the-way places for records of their first appearance, or to derive this information by deduc-

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] **Bruce, David, & Court, Arnold.** Trees for the Aleutians. Geogr. Rev. **35**: 418–423. 1945.

tion and assumption. It may be anticipated that sometime in the future knowledge will be needed of the introductions made during the recent military occupation of these islands. It seems advisable, therefore, to record here some introductions additional to those noted in the Geographical Review and to suggest that other records be published where future students can readily obtain them.

In the collections from Attu Island made in 1944 by Lt. G. B. Van Schaack of the U. S. N. R. and Mr. Robert Morehouse of the U. S. Army, there appeared specimens of *Brassica napus* L., rape, and *B. juncea* (L.) Coss., brown or Indian mustard. These were identified by L. H. Bailey, who has given special attention to the cultivated brassicas and has urged the collecting of more herbarium material of these variable and widespread crops. The Attu collectors reported that the plants appeared to have sprung from seeds dropped from Japanese military stores during their short occupation of this island. There was no indication that they were deliberately planted. The fact that these specimens were in full flower suggests the ability of the species to survive an Aleutian winter. However, Lt. Van Schaak reports that these were not seen during 1945.

Lieutenant Soren Nelson, of the Army Engineers, recently reported to the Smithsonian Institution a list of seeds of trees and shrubs which were sown on Amchitka Island during May, 1945 on bone-heap mounds left by the Aleuts. The species planted are reported to be *Pinus strobus, Tsuga canadensis, Tsuga caroliniana, Picea canadensis, Abies balsamea, Amelanchier laevis, Crataegus submollis, Betula papyrifera minor, Ilex verticillata, Cornus stolonifera, Rhododendron maximum, R. carolinianum, Kalmia latifolia, Vaccinium corymbosum,* and *Viburnum dentatum.* The seeds were secured from E. C. Haff of the Champion Paper & Fibre Co., Canton, North Carolina. The location of the mounds where these planting were made are shown on a map which appears on p. 23 of the July 1945 issue of the Scientific Monthly showing archeological sites of prehistoric villages.[3] The planted mounds are numbers 12, 15, and 16 on the map, also one at the base of Constantine Harbor on the north side of the island, another just west of site no. 25 in St. Makarius Bay, and the sixth is a short distance further west on the shore of the same bay.

The planting of acidophiles on bone or shell heaps does not forebode great survival. The exact origin of the seeds has not been stated, although a southeastern United States origin is suggested. The northern limit of range of all but one of these species is far south of the latitude of the Aleutian Islands. *Cornus stolonifera,* however, does occur commonly in Alaska.—Egbert H. Walker.

Book Review

Plantas Medicinales, Aromáticas o Venenosas de Cuba. By Juan Tomas Roig y Mesa. 872 pp. Illustrated. Havana: Republica de Cuba, Ministerio de Agricultura, Servicio de Publicidad y Divulgación (Publicaciones Técnicas). 1945.

This is not only a noteworthy contribution to the literature of the medicinal uses of Cuban plants but is also of value in understanding the flora of that island. Fully informed in the popular medical history and entirely competent in the botany of

[3] **Guggenheim, Paul.** An anthropological campaign on Anchitka. Sci. Monthly **61**: 21–32. *illustr. map.* 1945.

Cuba, Dr. Roig in the present work has lived up to his customary excellency, if not surpassed it.

The format of *Plantas Medicinales* is good. Although in the body of the book the plants are arranged in alphabetical sequence according to some one selected common name, the copious cross-references and indices are so complete that no difficulty is encountered in tracing any of the species treated. Besides the all-important index to the scientific names of the species, there are indices to their vernacular appellations in Cuba and other American countries, an arrangement of the plants according to the botanical classification of Engler & Gilg, and an extensive grouping according to their applications. In addition, there is a glossary to certain medical terms, and a bibliography of 94 entries dating from 1767 to 1944 listed in chronological sequence. The order generally adopted in treating the species is as follows: a preferred common name in large bold-face type, the scientific name and its family in italics, synonymy, other vernacular names with the regions where they are current, habitat and distribution, detailed botanical description, part of the plant used, applications with ample quotations from other authors, remarks on allied species, the plant's place in industry either local or general, and bibliography. Often chapters on the active principal or chemical composition and therapeutic properties are submitted. These discussions are set off by the use of diverse fonts.

The local names, botanical treatment, and medicinal uses listed in *Plantas Medicinales* often serve as a valuable supplement to those appearing in Dr. Roig's previous important books, *Diccionario Botanico de Nombres Vulgares Cubanos* and *Flora de Cuba* (*Datos para su Estudio*). The botanical collections of Dr. Roig available in the herbaria of The New York Botanical Garden and other institutions attest to his ability as a discriminating botanist and excellent field man, and his experience and knowledge are clearly reflected in *Plantas Medicinales*. This work will also serve as one of the cardinal sources of information when a modern Flora of Cuba is eventually written; and such a flora is urgently needed, for excepting Britton, Wilson & León's incomplete *Catalogue* there is still none for "The Pearl of the Antilles."

The references to the medicinal uses appearing in *Plantas Medicinales* have been painstakingly extracted from numerous authorities, and in many cases by Dr. Roig personally from local sources not available in print. The data are brought compactly together. But there remains one important task still undone. That is the necessity of subjecting the plants, for which there are numerous popular uses and reported properties, to exacting laboratory tests in fully equipped institutions. This study is very difficult and expensive. It requires the collection, often from difficult situations, of ample material of the correct part of a particular species, transportation over long distances to the laboratory where it must arrive in good condition, and then a seemingly infinite series of tests by chemists and pharmacologists. Then there may be only one success out of approximately a hundred tests. Yet all this is necessary, for otherwise the myriad references to plant uses by savages, lay doctors, and the common people individually or collectively, instead of being a precious heritage from countless generations, are a vain and valueless encumbrance of the literature in which they appear.

The importance of such studies is well understood by Dr. Roig, for in his "Prólogo" he avows that one of his objectives in writing *Plantas Medicinales* is to induce

scientists to study the Cuban plants reputed to be medicinal or poisonous; and he has repeatedly called attention in various articles and conferences to the desirability of subjecting these plants to chemical and clinical tests. He has also personally collected samples of some of the plants discussed in his book for analyses when the facilities of some of these tests have been made available to him.

Plantas Medicinales is an important work, presented by a capable man, who is willing to make improvements on his own work.—JOSEPH MONACHINO.

PROCEEDINGS OF THE CLUB

Minutes of the Meeting of October 2, 1945. The regular evening meeting of the Torrey Botanical Club was called to order by President Seaver at the Brooklyn Botanic Garden at 8.15 p.m. with 28 members present.

The Minutes were approved as read.

Two new members were accepted by the Club, one for associate membership, and one for annual membership.

Dr. Matzke moved that the Torrey Botanical Club publish in the Bulletin an account of the life and work of Professor C. C. Curtis who died April 10, 1945. The motion was carried unanimously.

Dr. Graves moved, and Dr. Avery seconded, a motion to approve a special meeting of botanists with the active participation of the Torrey Botanical Club early in January in honor of the New York Botanical Garden's fiftieth anniversary.

The rest of the meeting time was taken up with reports of summer field experiences. Dr. Small reported on the field trips of the Club. Dr. Shull reported on the summer work of the committee working to preserve Island Beach in its natural state. Dr. Lela Barton told of three weeks' visit in Guatemala and at Merck and Compay's Cinchona plantation there.

The meeting was adjourned at 9.20 p.m. and refreshments were served.

Respectfully submitted,

FRANCES E. WYNNE,
Recording Secretary

Minutes of the Meeting of November 7, 1945. The regular evening meeting of the Torrey Botanical Club was called to order by President Seaver at Hunter College at 8.15 p.m. with 40 members and friends present.

The minutes were approved as read.

Two persons were unanimously elected to annual membership.

There was no business, so the remainder of the meeting time consisted of a scientific program by Dr. Bassett Maguire: "Plant Collecting in the Desert and Mountain Regions of Nevada." The speaker's abstract follows:

> The New York Botanical Garden–Utah State Agricultural College Intermountain Region field study for 1945 was made in south-central Nevada and adjacent California. For more than three and one-half months, intensive collecting was carried on in the Quinn Canyon, the Monitor, Toquima, Toiyabe, and Shoshone Ranges, and intervening low desert areas in Nye County, the Silver Peak Range, Esmeraldo County, and the White Mountains in Inyo and Mono Counties, California.

Report on the itinerary, the terrain and vegetation was made by means of kodachrome slides.

After the showing of excellent kodachrome pictures, there was considerable discussion.

The meeting was adjourned at 9.45 p.m. and tea was served by the Hunter Faculty.

Respectfully submitted,

FRANCES E. WYNNE,
Recording Secretary

INDEX TO AMERICAN BOTANICAL LITERATURE

PLANT TAXONOMY AND FLORISTICS

(exclusive of fungi)

(See also under Morphology: **Erdtman**; Martens)

Allard, H. A. An interesting raspberry, *Rubus illecebrosus* Focke, new to West Virginia. Castanea **10**: 113–115. D 1945.

Ammons, N. & Core, E. L. Huckleberries, blueberries and cranberries of West Virginia. Castanea **10**: 103–109. *2 pl.* D 1945.

Amshoff, G. J. H. Notes on the Myrtaceae of Suriname. Med. Bot. Mus. Utrecht **86**: 147–165. *f. 1–4.* 1942.

Andrews A. L. Taxonomic notes V. The genus *Tetrapterum*. Bryologist **48**: 190–193. D 1945.

Baldwin, J. T. Cytogeography of *Emilia* Cass. in the Americas. Bull. Torrey Club **73**: 18–23. *f. 1–7.* Ja 1946.

Ball, C. R. Taxonomic botany in an argronomic journal. Jour. Am. Soc. Agron. **37**: 660, 661. Au 1945.

Barneby, R. C. A new species of *Asclepias* from Nevada. Leafl. W. Bot. **4**: 210, 211. 6 N 1945.

Barrett, M. F. *Ficus tsjahela*. Bull. Torrey Club **73**: 86–90. Ja 1946.

Barros, M. Una ciperácea nueva para el Paraguay. Lilloa **11**: 15–17. *1 f.* 15 S 1945.

Bean, R. C. *Betula papyrifera*, var. *commutata* in western Maine. Rhodora **47**: 405. 18 D 1945.

Beetle, A. A. The genus *Isolepis* R. Br. Am. Midl. Nat. **34**: 723–734. 15 N 1945.

Beetle, A. A. A new section Microphyllae in *Agrostis*. Bull. Torrey Club **72**: 541–549. *f. 1–8.* 27 N 1945.

Bell, F. H. The genus *Ranunculus* in West Virginia. Am. Midl. Nat. **34**: 735–743. 15 N 1945.

Benson, L. Nomenclatorial recombinations in *Trifolium* and *Opuntia*. Leafl. W. Bot. **4**: 209, 210. 6 N 1945.

Berg, A. Diatomeen von der Sophia-Expedition in Jahre 1883. Ark. Bot. **32A**[1]: 1–34. *pl. 1–8. tables 1–8.* 28 Au 1945.

Boivin, B. Notes sur le genre *Rosa* dans le Québec. Nat. Canad. **72**: 225–228. Jl–Au 1945.

Burkart, A. La Piperácea más austral en le República Argentina. Darwiniana **7**: 171–173. *1 f.* 15 O 1945.

Castellanos, A. Bromeliaceae argentinae novae vel criticae. VI. Lilloa **11**: 135–151. *f. 1–3.* 15 S 1945.

Cheney, R. H. Medicinal herbaceous species in the northeastern United States. Bull. Torrey Club **73**: 60–72. Ja 1946.

Clark, L. & Svihla, R. D. *Frullania strata*. Brologist **48**: 187–189. *f. 1–20.* D 1945.

Clausen, R. T. A review of the status of several American species of *Dalea*. Bull. Torrey Club **73**: 80–85. Ja 1946.

Conard, H. S. The Atracheata (Bryophyta) of Iowa. III. Mosses and persons in Iowa. A summary of the literature of mosses in Iowa. Bryologist **48**: 161–170. D 1945.

Conard, H. S. *et al.* The Bryophyte herbarium. A moss collection: preparation and care. Bryologist **48**: 198–202. *f. 1, 2.* D 1945.

Core, E. L. On the need for revision of the International Code of Botanical Nomenclature. Castanea **10**: 116–119. D 1945.

Core, E. L. Ramps. Castanea **10**: 110–112. *1 fig.* D 1945.

Covas, G. & Schnack, B. El valor taxonómico de la relación "Longitud del pistilo: Volumen del grano de polen." Darwiniana **7**: 80–90. 15 O 1945.

Cronquist, A. Notes on the Compositae of the northeastern United States. II. Heliantheae and Helenieae. Rhodora **47**: 396–403. 18 D 1945.

Cronquist, A. Studies in the Sapotaceae—IV. The North American species of *Manilkara*. Bull. Torrey Club **72**: 550–562. 27 N 1945.

Damann, K. E. Plankton studies of Lake Michigan. Am. Midl. Nat. **34**: 769–796. *f. 1–6. 15* N 1945.

Deam, C. *et al.* Indiana plant distribution records, V. 1944. Proc. Ind. Acad. **54**: 91–99. 1945.

Dugand, A. Noticias botanicas colombianas, V. Caldasia **3**[14]: 357–361. *illust.* 20 S 1945.

Dutilly, A. & Lepage, E. Coup d'oeil sur la flore subarctique du Québec de la baie Jomes au lac Mistassini. Nat. Canad. **72**: 185–224. *f. 1–6.* Jl–Au 1945, 266–288. *f. 7–10.* S–O 1945.

Dwyer, J. D. The taxonomy of the genus *Sauvagesia* (Ochnaceae). Bull. Torrey Club **72**: 521–540. *f. 1.* 27 N 1945.

Emons, R. W. A revision of the Central American species of *Smilacina*. Ann. Mo. Bot. Gard. **32**: 395–410. *pl. 18, 19.+f. 1.* N 1945.

Erickson, R. O. The *Clematis Fremontii* var. *Riehlii* population in the Ozarks. Ann. Mo. Bot. Gard. **32**: 413–460. *f. 1–22.* N 1945.

Fernald, M. L. "Ia." sometimes stands for Indiana. Rhodora **47**: 404, 405. 18 D 1945.

Fors, J. M. El *Aleurites trisperma* en Cuba. Rev. Soc. Cub. Bot. **2**: 102, 103. *illust.* Jl–Au 1945.

Gilbert, W. J. Studies on Philippine Chlorophyceae—II. Survey of literature and list of recorded species prior to 1940. Bull. Torrey Club **73**: 73–79. Ja 1946.

Goodspeed, T. H. Cytotaxonomy of *Nicotiana*. Bot. Rev. **11**: 533–592. D 1945.

Gould, F. W. Additions to the flora of Utah. Leafl. W. Bot. **4**: 212, 213. 6 N 1945.

Graff, P. W. Additions to the flora of Greenville County, South Carolina. Castanea **10**: 93–103. D 1945.

Grondona, E. M. Las especies argentinas del género *Monnina* (Polygalaceae). Darwiniana **7**: 1–37. *f. 1–15.* 15 O 1945.

Habeeb, H. Some mosses from Windsor, Nova Scotia. Rhodora **48**: 1–4. Ja 1946.

Henrard, J. T. New grasses from Suriname. Med. Bot. Mus. Utrecht **85**: 141–146. *illust.* 1942.

Hernandez, P. La flora maravillosa de Tepoztlán. Bol. Soc. Bot. Mex. **3**: 13–15. O 1945.

Hernandez Xolocotzi E. Notas sobre las palmas de México. Bol. Soc. Bot. Mex. **3**: 3, 4. O 1945.

Hitchcock, C. Leo. The South American species of *Lepidium*. Lilloa **11**: 75–134. *f. 1–44.* 15 S 1945.

Hitchcock, C. L. & Thompson, J. W. Noteworthy plants of Idaho. Leafl. W. Bot. **4**: 197–206. 6 N 1945.

Howell, J. T. New varieties of *Calyptridium Parryi*. Leafl. W. Bot. **4**: 214–216. 6 N 1945.

Howell, J. T. Some weedy species of *Lathyrus*. Leafl. W. Bot. 4: 213, 214. 6 N 1945.

Howell, J. T. Studies in *Carex*—I. Leafl. W. Bot. 4: 206–208. 6 N 1945.

Hull, E. D. *Campanula rapunculoides* in Indiana. Rhodora 47: 404. 18 D 1945.

Johnson, B. L. Cyto-taxonomic studies in *Oryzopsis*. Bot. Gaz. 107: 1–32. *f. 1–82*. 28 S 1945.

Jonker, F. P. The genus *Jussieua* L. (Oenotheraceae) in Suriname. Med. Bot. Mus. Utrecht 83: 147–150. *f. 1*. 1942.

Jonker, F. P. Remarks on the South American species of the genus *Cassipourea* (Rhizophoraceae). Med. Bot. Mus. Utrecht 84: 373–377. 1942.

Kearney, T. H. A new name in *Astragalus*. Leafl. W. Bot. 4: 216. 6 N 1945.

Keng, Yi-Li & Keng, Kwan-Hou. *Kokonoria*, a new genus of Plantaginaceae from Tsinghai Province, China. Jour. Wash. Acad. 35: 374–378. *f. 1–17*. 15 D 1945.

Krapovickas, A. El género *Neobaclea* (Malvaceae) y su distribución geográfica en la República Argentina. Darwiniana 7: 108–112. *pl. 1.+f. 1, 2*. 15 O 1945.

Leake, D. V. The algae of Crystal Lake, Cleveland County, Oklahoma. Am. Midl. Nat. 34: 750–168. 15 N 1945.

Leon Frère. Études taxonomiques sur la flore de Cuba. V. Nouveaux *Anastraphia* de la flore cubaine. Contr. Inst. Bot. Univ. Montreal 49: 77–86. *f. 1–4*. 1944 [1945].

Lepage, E. The lichen and bryophyte flora from James Bay up to Lake Mistassini. Bryologist 48: 171–186. D 1945.

Looser, G. El género *Notholaena* en Chile. Darwiniana 7: 62–70. 1 pl. 15 O 1945.

Looser, G. Lista provisional de las pteridofitas (helechos) de la provincia de Coquimbo, Chile. Lilloa 11: 55–73. 15 S 1945.

Looser, G. Sobre la pteridofita argentino-chilena *Lycopodium confertum*. Lilloa 11: 5–13. *pl. 1–4*. 15 S 1945.

Marie-Victorin, Frère. Études taxonomiques sur la flore de Cuba. I. Mise au point sur les Lobéliacees de l'île de Cuba. Contr. Bot. Univ. Montreal 49: 3–18. *f. 1–5*. 1944. [1945].

Marie-Victorin, Frère. Études taxonomiques sur la flore de Cuba. II. Les *Cascaria ilicoides* de l'île de Cuba. Contr. Inst. Bot. Univ. Montreal 49: 19–56. *f. 1–16*. 1944 [1945].

Marie-Victorin, Frère. Études taxonomiques sur la flore de Cuba. III. L'*Acacia serpentinicole* de Moa. Contr. Inst. Bot. Univ. Montreal 49: 57–67. *f. 1–7*. 1944 [1945].

Marie-Victorin, Frère. Études taxonomiques sur la flore de Cuba. IV. Un nouveau *Laplacea serpentinicole*. Contr. Inst. Bot. Univ. Montreal 49: 69–75. *f. 1. 2*. 1944 [1945].

Martin, A. C. Instability in scientific names of plants. Am. Midl. Nat. 34: 799, 800. 15 N 1945.

Mathias, M. E. & Constance, L. Umbelliferae [conclusion]. N. Am. Flora 28B: 161–295. 28 D 1945.

Moldenke, H. N. The known geographic distribution of the members of the Verbenaceae and Avicenniaceae: Supplement 4. Am. Jour. Bot. 32: 609–612. *f. 1–2*. 30 N 1945.

Monachino, J. A revision of *Hancornia* (Apocynaceae). Lilloa 11: 19–48. 15 S 1945.

Murrill, W. A. A white blackberry. Jour. Hered. **36**: 217, 218. *1 f.* 1945.

Paray, L. Nuevas localidades de algunas plantas. Bol. Soc. Bot. Mex. **3**: 16, 17. O 1945.

Pittier, H. Leguminos de Venezuela. I. Papilionáceas. Servicio Bot. [Caracas] Bol. Tec. **5**: 1–171. *pl. 1–81. f. 1–59.* S 1944.

Pittier, H. *et al.* Catálogo de la flora venezolana. 1. 3a Conferencia Interamericana de agricultura **20**: 1–423. 1945.

Ponce de León, A. Joyas de la flora cubana. El dagame (*Calycophyllum candidissimum* D. C.). Rev. Soc. Cub. Bot. **2**: 99. *illust.* Jl–Au 1945.

Raup, H. M. Phytogeographic studies in the Athabaska-Great Slave Lake Region. II. Jour. Arnold Arb. **27**: 1–85. *pl. 1–5.+f. 1–6.* 15 Ja 1945.

Rickett, H. W. Bibliography: Volume 28 B [North American Flora]. N. Am. Flora **28B**: 317–374. 28 D 1945.

Rickett, H. W. Cornales. N. Am. Flora **28B**: 297–316. 28 D 1945.

Roldán, A. El nogal de nuez encarcelada en el Valle de México. Bol. Soc. Bot. Mex. **3**: 9–12. *f. 1.* O 1945.

Roldán, A. Un arbol que se extingue en la Cañada de Contreres, D. F. Bol. Soc. Bot. Mex. **3**: 5, 6, O 1945.

Rolland-Germain, Frère. Un *Lycopus* endémique de l'estuaire du Saint-Laurent. Nat. Canad. **72**: 177–184. *4 f.* Jl–Au 1945.

Sharp, A. J. Notas sobre la flora del centro de Chiapas. Bol. Soc. Bot. Mex. **3**: 7. O 1945.

Schnooberger, I. & Wynne, F. E. The Bryophytes of Shenandoah National Park, Virginia. Bull. Torrey Club **72**: 506–520. 27 N 1945.

Schweinfurth, C. A new small flowered *Brassia*. Am. Orchid Soc. Bull. **14**: 248–250. *1 pl.* N 1945.

Schweinfurth, C. A novel *Miltonia* from Peru. Am. Orchid Soc. Bull. **14**: 294–296. *1 pl.* D 1945.

Shaver, J. M. Tennessee spleenworts II. Jour. Tenn. Acad. **20**: 326–362. *f. 71–91.* O 1945.

Smith, A. C. Studies of South American plants, XI. Noteworthy species of Hippocrateaceae and Vacciniaceae. Jour. Arnold Arb. **27**: 86–120. *f. 1–4.* 15 Ja 1946.

Standley, P. C. Notes on some Guatemalan trees. Trop. Woods **84**: 1–18. 1 D 1945.

Swart, J. J. A monograph of the genus *Protium* and some allied genera (Burseraceae). Med. Bot. Mus. Utrecht **90**: 211–446. *f. 1–7.* 1942.

Swart, J. J. Novitates Burseracearum. Med. Bot. Mus. Utrecht **89**: 189–210. 1942.

Taft, C. E. The desmids of the west end of Lake Erie. Ohio Jour. Sci. **45**: 180–205. *pl. 1–5* S 1945.

Tamayo, F. Las especies argentinas del género *Machaerium*. Darwiniana **7**: 120–137. *f. 1–4.* 15 O 1945.

Tamayo, F. Una familia de plantas nueva para Venezuela, con observaciones sobre epifitismo y parasitismo. Bol. Soc. Venez. Ci. Nat. **1**: 165–169. 1 My 1932.

Uribe-Uribe, L. Especies nuevas o notables del genero *Inga* en Colombia. Caldasia **3**[14]: 345–356. *pl. 1, 2.* 20 S 1945.

Whelden, R. M. Notes on Argentine Charas. Farlowia **2**: 305–308. *f. 1–5.* Ja 1946.

White, C. T. The Australian species of *Antirhea*, and a new name for a Cuban species. Jour. Arnold Arb. **27**: 121, 122. *pl. 1.* 15 Ja 1946.

Williams, R. S. Una colección de musgos de los Andes venezolanos. Bol. Soc. Venez. Ci. Nat. **2**: 172–177. 31 Ja 1934.

Wolf, W. × *Quercus capesii:* a supplementary note. Castanea **10**: 120. D 1945.

Zaneveld, J. S. Some notes on Charophyta, collected in the Netherlands West Indies, North Venezuela and Colombia. Med. Bot. Mus. Utrecht **82**: 141–146. 1942.

MORPHOLOGY

(including anatomy, and cytology in part)

(See also under Plant Physiology: **Levine**)

Avery, G. S., Piper, M. & Smith, P. Cell number in successive segments of *Avena* coleoptiles of different ages: materials for the biochemist. Am. Jour. Bot. **32**: 575–579. *f. 1, 2.* 30 N 1945.

Carlson, M. C. Megasporogenesis and development of the embryo sac of *Cypripedium parviflorum*. Bot. Gaz. **107**: 107–114. *f. 1–18.* 28 S 1945.

Chrysler, M. A. The shoot of *Botrychium* interpreted as a series of dichotomies. Bull. Torrey Club **72**: 491–506. *f. 1–33.* 27 N 1945.

Cooper, W. C., Burkett, A. L. & Herr, A. Flowering of Peruvian cube, *Lonchocarpus utilis* A. C. Smith, induced by girdling. Am. Jour. Bot. **32**: 655–657. *f. 1, 2.* D 1945 [Ja 1946].

Erdtman, G. Pollen morphology and plant taxonomy. II. Notes on some monocotyledonous pollen types. Svensk Bot. Tids **38**: 163–168. *f. 1, 2.* 1944. III. *Morina L.* With addition on pollenmorphological terminology. **39**: 187–191, *f 1–9.* 1945. IV. Labiatae, Verbenaceae and Avicenniaceae. 279–285. *f. 1–8.* V. On the occurrence of tetrads and dyads. 286–297. *f. 1–2.*

Frier, F. Relación entre la anatomía foliar del género *Neurolepis* (Gramineae) y su posición sistemática. Darwiniana **7**: 103–107. 15 O 1945.

Gavio, H. S. Anomalías en el androceo del seibo (*Erythrina crista-galli* L.). Darwiniana **7**: 113–119. *pl. 1* + *f. 1–3.* 15 O 1945.

Lawalrée, A. La multiplication vegetative des Lemnacées, en particulier chez *Wolffia arrhiza*. (Recherches embryologiques et cytologiques.) Cellule **49**: 337–382. *pl. 1–8.* + *f. 1–23.* 1943.

Limbach, J. P. & Paul, B. H. Variation in the specific gravity of balsa and its relation to longitudinal shrinkage. Trop. Woods **84**: 18–23. 1 D 1945.

Lizer y Trelles, C. A. & Molle, C. C. Estructura anatómica de filocecidias neotrópicas. Lilloa **11**: 153–187. *pl. 1–21* + *f. 1–31.* 15 S 1945.

Looby, W. J. & Doyle, J. Fertilization and early embryogeny in *Podocarpus andinus*. Sci. Proc. R. Dublin Soc. **23**: 257–270. *pl. 11–14.* Au 1944.

Looby, W. J. & Doyle, J. The gametophytes of *Podocarpus andinus*. Sci. Proc. R. Dublin Soc. **23**: 222–237. *pl. 6–9.* Au 1944.

Martens, P. & Pirard, N. Les organes glanduleux de *Polypodium virginianum* L. II. Structure, origine et signification. Cellule **49**: 385–406. *pl. 1–3.* 1943.

Martínez Crovetto R. Nuevos casos teratológicos en Gramíneas. Darwiniana **7**: 91–102. *f. 1, 2.* 15 O 1945.

Miller, H. A. & Wetmore, R. H. Studies in the developmental anatomy of *Phlox Drummondii* Hook. I. The embryo. Am. Jour. Bot. **32**: 588–599. *f. 1–44.* 30 N 1945. II. The seedling. 628–634. *f. 1–12.* D 1945 Ja 1946.

Skottsberg, C. The flower of *Canthium*. Ark. Bot. **32A**[5]: 1–12. *f. 1–43.* + *tables 1, 2.* 16 N 1945.

Tortorelli, L. A. La disposición estratificada de los elementos leñosos en al ibirapitá (*Muellera Glaziovii*). Darwiniana **7**: 58–61. *pl. 1. 15* O 1945.

Venning, F. D. Accessory vascular bundles in *Murraya koenigii* (Linn.) Spreng. (Rutaceae: Aurantioideae). Jour. Wash. Acad. **35**: 352–356. *f. 1–12.* 15 N 1945.

Webber, I. E. The wood of *Ambelania laxa* Muell. Arg. Lilloa **11**: 49–53. *pl. 1, 2.* 16 N 1945.

Welch, Walter B. Cicatrization in leaves of *Bryophyllum calycinum*. Bot. Gaz. **107**: 95–106. *f. 1–37.* 28 S 1945.

Whittenberger, R. T. & Kelner, A. Rubber in *Cryptostegia* leaf chlorenchyma. Am. Jour. Bot. **32**: 619–627. *f. 1–11.* D 1945 [Ja 1946].

Wright, J. W. Epidermal characters in *Fraxinus*. Proc. Ind. Acad. **54**: 84–90. *pl. 1, 2.* 1945.

PLANT PHYSIOLOGY

Avery, G. S. & Pottorf, L. Polyploidy, auxin and nitrogen in green plant tissue. Am. Jour. Bot. **32**: 669–671. D 1945 [Ja 1946].

Avery, G. S. & Pottorf, L. Auxin and nitrogen relationships in green plants. Am. Jour. Bot. **32**: 666–669. D 1945 [Ja 1946].

Erickson, L. C. The water factor in transplanting guayule. Am. Jour. Bot. **32**: 634–643. *f. 1–10.* D 1945 [Ja 1946].

Levine, M. The effect of colchicine and acenaphthene in combination with x-rays on plant tissue. I. Bull. Torrey Club **72**: 563–574. 27 N 1945. II. **73**: 34–59. *f. 1–43.* Ja 1946.

Levring, T. The oxidation and assimilation of acetic acid by *Torula utilis*. Ark. Bot. **32A**[4]: 1–11. *f. 1–6. tables 1–5.* 28 Au 1945.

Levring, T. Some experiments on the conversion of acetic and lactic acid with baker's yeast. Ark. Bot. **32A**[3]: 1–24. *f. 1–9. tables 1–11.* 28 Au 1945.

Lihnell, D. Keimungsversuche mit Pyrolasamen. Symb. Bot. Upsal. **6**[3]: 1–37. *f. 1–6.* + *pl. 1, 2.* + *tables 1–3.* 1942.

McDermott, J. J. The effect of the moisture content of the soil upon the rate of exudation. Am. Jour. Bot. **32**: 570–574. *f. 1–2.* 30 N 1945.

Mitchell, J. W. & Brown, J. W. Effect of 2, 4-dichlorophenoxyacetic acid on the readily available carbohydrate constituents in annual morning glory. Bot. Gaz. **107**: 120–129. *f. 1–4.* 28 S 1945.

Osterhout, W. J. V. Water relations in the cell. I. The chloroplasts of *Nitella* and of *Spirogyra*. Jour. Gen. Physiol. **29**: 73–78. *f. 1, 2.* 28 N 1945.

Scully, N. J., Parker, M. W. & Borthwick, H. A. Interaction of nitrogen nutrition and photoperiod as expressed in bulbing and flowerstalk development of onion. Bot. Gaz. **107**: 52–61. *f. 1–3.* 28 S 1945.

Stout, M. Translocation of the reproductive stimulus in sugar beets. Bot. Gaz. **107**: 86–95. *f. 1–4.* 28 S 1945.

Went, F. W. & Cosper, L. Plant growth under controlled conditions. VI. Comparison between field and air-conditioned greenhouse culture of tomatoes. Am. Jour. Bot. **32**: 643–654. *f. 1–10.* D 1945 [Ja 1946].

Whittenberger, R. T. Silicon absorption by rye and sunflower. Am. Jour. Bot. **32**: 539–549. *f. 1, 2.* 30 N 1945.

Wiken, T. & Agren, G. Studies on the growth of *Phycomyces Blakesleeanus* in connection with determination of the thiamin inactivating fish factor. Ark. Bot. **32A**[9]: 1–19. *f. 1–4.* + *tables 1–9.* 16 N 1945.

Wilson, J. K. The symbiotic performance of isolates from soybean with species of *Crotalaria* and certain other plants. Cornell Exp. Sta. Mem. **267**: 1–20. *tables 1, 2.* Mr 1945.

GENETICS

(including cytogenetics)

(see also under Mycology & Phytopathology: **McKinney & Clayton; LeClerg**)

Castronovo, A. Estudio cariológico de doce especies de Leguminosas argentinas. Darwiniana **7**: 38–57. *f. 1, 2.* 15 O 1945.

Chilton, S. J. P., Lucas, G. B. & Edgerton, C. W. Genetics of *Glomerella*. III. Crosses with a conidial strain. Am. Jour. Bot. **32**: 549–554. *f. 1–3.* 30 N 1945.

Johnson, B. L. Natural hybrids between *Oryzopsis hymenoides* and several species of *Stipa*. Am. Jour. Bot. **32**: 599–608. *f. 1–71.* 30 N 1945.

Johnson, L. P. V. Reduced vigour, chlorophyll deficiency, and other effects of self-fertilization in *Pinus*. Canad. Jour. Res. **23C**: 145–149. *f. 1.* O 1945.

Randall, T. E. & Rick, C. M. A cytogenetic study of polyembryony in *Asparagus officinalis* L. Am. Jour. Bot. **32**: 560–569. *f. 1–8.* 30 N 1945.

Riley, H. P. Inheritance of the main anthocyanin pigmentation and some of its patterns in flowers of *Nemesia strumosa*. Bot. Gaz. **107**: 32–52. *f. 1–4.* 28 S 1945.

Rollins, R. C. Evidence for genetic variation among apomictically produced plants of several F_1 progenies of guayule (*Parthenium argentatum*) and mariola (*Parthenium incanum*). Am. Jour. Bot. **32**: 554–560. *f. 1–8.* 30 N 1945.

Schlehuber, A. M. Inheritance of stem characters in certain sorghum varieties and their hybrids. Jour. Hered. **36**: 219–222. *1 f.* 1945.

Schnack, B. & Covas, G. Hibridación interspecífica en *Glandularia* (Verbenáceas). Darwiniana **7**: 71–79. *pl. 1.5. f. 1–2. 15* O 1945.

Stout, A. B. Classes and types of intraspecific incompatibilities. Am. Nat. **79**: 481–508. N. 1945.

MYCOLOGY & PHYTOPATHOLOGY

(see also under Morphology: **Lizer y Trelles & Molle**)

Allington, W. B. Wildfire disease of soybeans. Phytopathology **35**: 857–869. *f. 1–4.* N 1945.

Briceño-Iragorry, L. Notes sobre micología. Bol. Soc. Venez. Ci. Nat. **1**: 407–410. 1934.

Chardon, C. E. & Toro, R. A. Exploraciones micológicas en Venezuela. Bol. Soc. Venez. Ci. Nat. **1**: 281–291. 1 Au 1932.

Cochrane, V. W. The common leaf rust of cultivated roses, caused by *Phragmidium mucronatum* (Fr.) Schlecht. Cornell Exp. Sta. Mem. **268**: 1–39. *f. 1–9. tables 1–19.* Mr 1945.

Costa, A. S. The relationship between American tobacco streak and Brazilian "Necrose Branca" or "Couve." Phytopathology **35**: 1029, 1030. *f. 1.* D 1945.

Drechsler, C. A nematode-destroying phycomycete forming immotile spores in aerial evacuation tubes. Bull. Torrey Club **73**: 1–17. *f. 1–36.* Ja 1946.

Fife, J. M. & Carsner, E. Tip burn of sugar beet with special reference to some light and nitrogen relations. Phytopathology **35**: 910–920. *f. 1–3.* N 1945.

Forbes, I. L. & Mills, P. J. Movement of mosaic virus through sugar-cane seed pieces. Phytopathology **35**: 705–709. *f. 1.* S 1945.

Hanson, A. M. A morphological, developmental, and cytological study of four saprophytic chytrids. II. *Rhizophydium coronum* Hanson. Am. Jour. Bot. **32**: 479–487. *f. 1–61.* O [9 N] 1945.

Harrington, H. D. Some host plants of *Comandra umbellata* in Colorado. Am. Midl. Nat. **34**: 797, 798. 15 N 1945.

Hesler, L. R. Notes on Southern Appalachian fungi. VII. Jour. Tenn. Acad. **20**: 363–372. O 1945.

Hewitt, W. B. A graft-transmissible mosaic disease of grapevine. Phytopathology **35**: 940–942. *f. 1.* N 1945.

Jenkins, A. E. Scab of *Cinchona* in South America caused by *Elsinoë*. Jour. Wash. Acad. **35**: 344–352. *f. 1–4.* 15 N 1945.

Karling, J. S. Brazilian chytrids. VII. Observations relative to sexuality in two new species of *Siphonaria*. Am. Jour. Bot. **32**: 580–587. *f. 1–53.* 30 N 1945.

LeClerg, E. L. Genetic leaf roll of Irish potato seedlings. Phytopathology **35**: 877–878. *f. 1.* N 1945.

Ling, Lee Epidemiology studies on stripe rust of wheat in Chengtu Plain, China. Phytopathology **35**: 885–894. *f. 1.* N 1945.

McClellan, W. D. Pathogenicity of the vascular *Fusarium* of *Gladiolus* to some additional iridaceous plants. Phytopathology **35**: 921–930. *f. 1–3.* N 1945.

McKinney, H. H. & Clayton, E. E. Genotype and temperature in relation to symptoms caused in *Nicotiana* by the mosaic virus. Jour. Hered. **36**: 323–331. *f. 1–6.* N 1945.

Magnusson, A. H. & Zahlbruckner, A. Hawaiian lichens. III. The families Usneaceae to Physiaceae. Index. Ark. Bot. **32A²**: 1–89. *pl. 1–10.* 28 Au 1945.

Mathews, F. P. A comparison of the toxicity of *Notholaena sinulata* and *N. sinuata* var. *cochisensis*. Rhodora **47**: 393–395. *f. 1.* 18 D 1945.

Miller, J. J. Studies on the *Fusarium* of muskmelon wilt, II. Infection studies concerning the host range of the organism and the effect of environment on disease incidence. Canad. Jour. Res. **23C**: 166–187. *11 f.* O 1945.

Murrill, W. A. New Florida fungi. Quart. Jour. Fla. Acad. **8**: 175–198. Je 1945.

Niederhauser, J. S. The rust of greenhouse-grown spearmint, and its control. Cornell Exp. Sta. Mem. **263**: 1–30. *f. 1–6. + tables 1, 2.* Mr 1945.

Peturson, B., Newton, M. & Whiteside, A. G. O. The effect of leaf rust on the yield and quality of wheat. Canad. Jour. Res. **23C**: 105–114. Au 1945.

Rangel, J. F. Two *Alternaria* diseases of cruciferous plants. Phytopathology **35**: 1002–1007. *f. 1–3.* D 1945.

Rodenhiser, H. A. & Holton, C. S. Distribution of races of *Tilletia caries* and *Tilletia foetida* and their relative virulence on certain varieties and selections of wheat. Phytopathology **35**: 955–969. D 1945.

Tapke, V. F. New physiologic races of *Ustilago hordei*. Phytopathology **35**: 970–976. D 1945.

Thirumalachar, M. J. Development of spore-forms and the nuclear cycle in the autoeciousopsis rust, *Cystospora oleae*. Bot. Gaz. **107**: 74–86. *f. 1–27.* 28 S 1945.

Walker, J. C. & Hooker, W. J. Plant nutrition in relation to disease development. II. Cabbage clubroot. Am. Jour. Bot. **32**: 487–490. O [9 N] 1945.

Weimer, J. L. A new species of *Colletotrichum* on vetch. Phytopathology **35**: 977–990. *f. 1–4.* D 1945.

Willison, R. S. A line-pattern virosis of Shiro plum. Phytopathology **35**: 991–1001. *f. 1–3.* O 1945.

Yu, T. F. The red-spot disease of broad beans (*Vicia faba* L.) caused by *Botrytis fabae* Sardiña in China. Phytopathology **35**: 945–954. D 1945.

Yu, T. F. *et al.* Preliminary stduies on physiologic specialization in *Tilletia tritici and T. levis* in China. Phytopathology **35**: 879–884. N 1945.

ECOLOGY & PLANT GEOGRAPHY

Allard, H. A. Flowering behavior and natural distribution of the eastern ragweeds (*Ambrosia*) as affected by length of day. Ecology **26**: 387–394. O [D] 1945.

Hoxmark, G. Bioclima de los citrus en el litoral argentino. Anal. Soc. Ci. Arg. **140**: 3–15. *map + 8 tables.* 1945.

Johnson, W. M. Natural revegetation of abandoned crop land in the ponderosa pine zone of the Pike's Peak region in Colorado. Ecology **26**: 363–374. *f. 1–6.* O [D] 1945.

Lemon, P. C. Wood as a substratum for perennial plants in the southeast. Am. Midl. Nat. **34**: 744–749. *f. 1–6.* 15 N 1945.

Moyle, J. B. Some chemical factors influencing the distribution of aquatic plants in Minnesota. Am. Midl. Nat. **34**: 402–420. 15 S 1945.

Rau, P. The Yucca plant, *Yucca filamentosa*, and the Yucca moth, *Tegeticula* (*Pronuba*) *yuccasella* Riley: an ecologico-behavior study. Ann. Mo. Bot. Gard. **32**: 373–394. N 1945.

GENERAL BOTANY
(including biography)

Honig, P. & Verdoorn, F. *editors.* Science and scientists in the Netherlands Indies. Natuur. Tijds. Nederlandsch Indië **102**: Special Suppl. *i–xxii*, 1–491. *f. 1–134.* 1945.

Mencía, M. & Ponce de León, A. El jardín botánico de la Universidad de la Habana. Rev. Soc. Cub. Bot. **2**: 85–89. *illust.* Jl–Au 1945.

Reeside, J. B. Edward Wilber Berry: February 10, 1875–September 20, 1945. Science **102**: 498, 499. 16 N 1945.

Reichert, F. & von Rentzell, I. Breve resumen de los resultados geográficos, geológicos y botánicos de la octava expedición patagónica, correspondiente al programa Reichert–Hichen, establecido en al año 1913, en el "Instituto Darwinion." Darwiniana **7**: 138–170. *pl. 1–4.* 15 O 1945.

Reko, B. P. Mitobotanica zapoteca. 1–154. *f. 1–7. frontisp.* Mexico, 1945.

Shantz, H. L. Frederic Edwards Clements (1874–1945). Ecology **26**: 317–319. *port.* O [D] 1945.

Waller, W. E. The vaulting imagination of John L. Ridell. Ohio Archaeol. Hist. Quart. **54**: 331–360. O–D 1945.

Zayas-Bazán y Perdomo, H. Historia de la botánica en Cuba. Rev. Soc. Cub. Bot. **2**: 107–110. Jl–Au 1945.